

R E P O R T R E S U M E S

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PUBLIC POLICY ISSUES, REPLY LEGAL BRIEF, AND TECHNICAL AND ECONOMIC DATA, BEFORE THE FEDERAL COMMUNICATIONS COMMISSION, IN THE MATTER OF THE ESTABLISHMENT OF DOMESTIC COMMUNICATIONS SATELLITE FACILITIES BY NON-GOVERNMENTAL ENTITIES, DOCKET 16495.

FORD FOUNDATION, NEW YORK, N.Y.

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THE THREE PARTS OF THIS FORD FOUNDATION SUBMISSION PROVIDE INFORMATION ON BROAD ISSUES OF ORGANIZATION AND PUBLIC POLICY AS THEY RELATE TO SATELLITE MODEL SYSTEMS DNS-3 AND DNS-4, ON LEGAL PROBLEMS OF AUTHORIZATION AND CONTROL, AND ON THE TECHNICAL CHARACTERISTICS, COSTS, AND BROADCAST SPECTRUM LIMITATIONS OF EACH SYSTEM. VOLUME I OUTLINES FINANCIAL ISSUES (POTENTIAL SAVINGS AND POSSIBLE TAX REVENUES), REVIEWS THE USES AND IMPLICATIONS OF NONCOMMERCIAL AND INSTRUCTIONAL TELEVISION IN THE UNITED STATES AND ABROAD, AND SUGGESTS THE PATTERN OF SERVICE TO BE FOLLOWED IN THE SATELLITE SYSTEM. IN VOLUME II, NUMEROUS LEGAL PRECEDENTS ARE INTRODUCED AFFIRMING FCC POWER TO AUTHORIZE SUCH SYSTEMS AND THE COMPATIBILITY OF THE PROPOSAL WITH THE PUBLIC AND NATIONAL INTEREST. VOLUME III INCLUDES BACKGROUND MATTER ON COMMON CARRIERS AND EXISTING NETWORKS, AND CHARTS AND FIGURES ON SATELLITE TRANSMISSION, MICROWAVE RELAY, AND ELECTROMAGNETIC INTERFERENCE. THE STUDY MADE BY IBM, OF POTENTIAL INTERFERENCE IN THE GREATER NEW YORK CITY AREA IN A SEVERE RAINSTORM, IS INCLUDED. (LY)

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VOLUME I

Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D.C. 20554

In the Matter of the

Establishment of domestic communications
satellite facilities by non-governmental
entities.

DOCKET
No. 16495

PUBLIC POLICY ISSUES

REPLY COMMENTS OF THE FORD FOUNDATION IN
RESPONSE TO THE COMMISSION'S NOTICE OF INQUIRY
OF MARCH 2, 1966, AND SUPPLEMENTAL NOTICE OF
INQUIRY OF OCTOBER 20, 1966.

December 12, 1966

The Ford Foundation
New York, New York

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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AC000771

THE FORD FOUNDATION
477 MADISON AVENUE
NEW YORK, NEW YORK 10022

McGEORGE BUNDY
PRESIDENT

December 12, 1966

Dear Mr. Chairman:

I enclose the reply comments of the Ford Foundation in the proceedings of your Commission on domestic satellite communication. (Docket No. 16495.) I am of course sending copies of this letter and our comments to each of your colleagues.

This further submission is intended to be responsive to the questions the Commission has asked, and also to questions raised by others since August 1. It is an extensive document, but the issues of policy, law, and technology are not simple.

The purpose of the Ford Foundation in this proceeding remains unchanged. We believe that any national decision on the future of domestic satellites should take full account of the needs and promise of educational television. Our prolonged and heavy investment in the field makes it our evident duty to present our findings. In August we presented a preliminary proposal. Now in December -- after extensive consultation and study -- we are able to report that our convictions have been reinforced: we believe that satellites can transform the world of television by interconnecting and reinforcing that half of it -- the non-commercial half -- that still struggles in isolated stations.

We continue to believe that domestic satellite service can provide free channels for educational television and also generate important funds for programming. We have had time to refine our analysis; we are most grateful to all who have helped us to learn more about the problem. We find that both the costs and the potential revenues of an effective satellite service are likely to be somewhat higher than we thought last summer. The networks need a stronger service than we suggested in August, but there are more sources of revenue in sight than we then supposed. The prospective savings are large, and we conclude that the eventual promise of satellites is even greater than we at first believed.

Our experience since August 1 has taught us the value of competition in ideas in this field. Our own model is more effective than the one we put forward then and the presence of alternatives has been good for us. Others with other views have repeatedly assured us that the dialogue over our differences has also been helpful and

instructive to them. Friends in non-commercial television have had offers and proposals from the common carriers which were not there in July. We believe that if all these gains can be obtained from a single proposal filed with the Commission by a single non-operating institution, it may be in everyone's interest to ensure in some way that competition in ideas continues.

The present submission examines a large number of subordinate issues and reaches a number of important conclusions. Your Commission and its experts will wish to study the full text. We have again called on men and organizations whose competence in their several disciplines is recognized. It may be useful for me to summarize the new propositions that have come to seem most significant to us in the course of the work of these recent months.

We submit:

1. That the promise of both educational and instructional television was, if anything, understated in our initial submission. This view derives from scores of discussions and exchanges with men of experience and wisdom in many callings and in all parts of the country. We have developed and extended this point in the current submission.

2. That ETV has need for large funds, beyond what a satellite service can provide, and that there are a number of promising ways to obtain such support. We have included a technical study of some of these possibilities, but we believe that in this field it is particularly important to await the conclusions of the Carnegie Commission.

3. That it is time -- without waiting for satellites -- for prompt and imaginative experiments to show the power of live non-commercial network television, and that the Ford Foundation should help pay for such experiments by grants. The Trustees have appropriated \$10 million for this purpose.

4. That there is no serious legal doubt of the power of the FCC to authorize a non-profit satellite service if it finds such a service to be needed in the national interest.

5. That the general public interest will be better served if a portion of the savings from satellites is used to give free channels and program funds to educational television than if all of the savings are used to provide a marginal decrease in general communication rates now charged by common carriers.

6. That the problems of organization and management are serious, but readily soluble, and in ways that not only preserve but increase the plurality, diversity and freedom of education, information, and culture in this country. (We repeat, with emphasis, that the Ford Foundation will neither operate nor manage anything whatever in this field.)

7. That the interference problem is less significant, even in the worst circumstances, than has been feared, and that it can be solved. We present in our Comments a study on interference that supports this view.

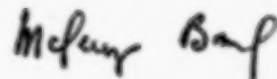
8. That if there is need for a national test satellite program to permit confident final decisions, NASA is the proper manager of such a program; the Foundation will contribute to such a program in appropriate ways.

9. That the wide public response to our proposal is more remarkable than the proposal itself. People all over the country appear to be strongly stirred by the notion of a "people's dividend" -- that a part of the savings made possible by public investment in space should be dedicated, by a national decision, to the high public purpose of effective non-commercial television.

Conclusion

The future of non-commercial television and domestic satellites is a great subject, and naturally engages both wide public interest and intense commercial concern. Common carriers and commercial broadcasters are deeply interested in the matter. These industries are subject both to corporate pressure for profit and to varying degrees of regulatory control. These pressures could make their leaders quick to resent new ideas from outsiders. It is therefore a pleasure and an obligation, in presenting this second submission, to acknowledge the courtesy and understanding with which our efforts have been greeted by the recognized leaders of both industries. These men may not agree with all that we say, but they have recognized the importance of the cause we plead, and have joined with us in discussing the many complex and technical questions which the Commission has asked. This cooperation gives us great hope that the continuing national debate will be conducted with good will and good temper, and that the eventual decision -- like the debate itself -- will serve the higher interests of all.

Sincerely,



McGeorge Bundy

The Honorable Rosel H. Hyde
Chairman
Federal Communications Commission
Washington, D. C.

NOTE

The Ford Foundation's reply comments to the Commission's Notice of Inquiry of March 2, 1966, as amended by the Supplemental Notice of Inquiry of October 20, 1966, are submitted in three volumes:

Volume I - Public Policy Issues

Reply Comments of the Ford Foundation in Response to the Commission's Notice of Inquiry of March 2, 1966, and Supplemental Notice of Inquiry of October 20, 1966.

Volume II - Reply Legal Brief

Reply Legal Brief and Comments of the Ford Foundation in Response to Paragraphs 4(a) and 4(b) of the Commission's Notice of Inquiry of March 2, 1966, and Paragraphs 3(b), 3(c)(5), and 3(d) of the Supplemental Notice of Inquiry of October 20, 1966.

Volume III - Technical and Economic Data

Technical and Economic Comments of the Ford Foundation in Response to Paragraphs 4(c)(1), 4(c)(4), and 4(d) of the Commission's Notice of Inquiry of March 2, 1966, and Paragraphs 3(a), 3(c)(2), 3(c)(3), and 4 of the Supplemental Notice of Inquiry of October 20, 1966.

VOLUME I

Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D. C. 20554

In the Matter of the

Establishment of domestic communications
satellite facilities by non-governmental
entities.

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PUBLIC POLICY ISSUES

REPLY COMMENTS OF THE FORD FOUNDATION IN
RESPONSE TO THE COMMISSION'S NOTICE OF INQUIRY
OF MARCH 2, 1966, AND SUPPLEMENTAL NOTICE OF
INQUIRY OF OCTOBER 20, 1966.

December 12, 1966

The Ford Foundation
New York, New York

VOLUME I

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C. 20554

FCC 66-207
80142

In the Matter of the)
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Establishment of domestic non-)
common carrier communication-) DOCKET NO. 16495
satellite facilities by)
non-governmental entities.)

NOTICE OF INQUIRY

By the Commission:

1. The Commission has before it an application filed by the American Broadcasting Companies, Inc. (ABC) for the establishment of a domestic TV program distribution system using a synchronous satellite. An opposition to the application has been filed by the Communications Satellite Corporation and a reply thereto has been filed by ABC. Under the proposal, programs would be transmitted from earth stations located in New York City and Los Angeles to ABC-owned and affiliated stations throughout the United States, including Hawaii and Alaska, and Puerto Rico and the Virgin Islands. The application also proposes to provide facilities for the interconnection of non-commercial educational TV stations in these same areas.
2. The ABC application is technically defective as it fails to comply with various provisions of Parts 2, 21 and 74 of the Commission's Rules and Regulations. The Commission has, therefore, informed ABC that its application cannot be accepted for filing at this time and the application is being returned to ABC without prejudice to an appropriate refiling thereof in light of the outcome and disposition of the inquiry that we are instituting.
3. The Commission has a statutory responsibility to study new uses for radio and generally encourage the larger and more effective use of radio in the public interest (e. g. Section 303(g) of the Communications Act of 1934, as amended). However, proposals for the construction and operation of communication-satellite facilities by entities for the purpose of meeting their private or specialized domestic communication requirements present significant questions as to the compatibility of such proposals with the purposes, policies and objectives of the Communications Satellite Act of 1962 and as to their technical and economic feasibility. Therefore the Commission believes that the public interest would be served by obtaining the views and

comments of interested parties on these questions as a means of determining what further actions, if any, are warranted by the Commission in this area.

4. Accordingly, comments are invited on the following specific questions:

- (a) Whether, as a matter of law, the Commission may promulgate policies and regulations, looking toward the authorization of non-governmental entities to construct and operate communication-satellite facilities for the purpose of meeting their private or specialized domestic communications requirements. This proceeding is not concerned with the question of whether communications common carriers may be authorized to construct and operate communication-satellite facilities for domestic purposes. (Parties submitting comments in this matter should do so in separate legal briefs);
- (b) The effect or impact of any such authorizations upon the policies and goals set forth by the Communications Satellite Act and upon the obligations of the United States Government as a signatory to the Executive Agreement Establishing Interim Arrangements for a Global Commercial Communications Satellite System;
- (c) Whether, as a matter of policy, it would be in the public interest to grant such authorizations considering:
 - (1) The amount of frequency spectrum now available for the communication satellite service under the Commission's Rules;
 - (2) The extent to which terrestrial facilities are or may be available to provide the services contemplated;
 - (3) The potential economic effects on common carriers; and
 - (4) The potential benefits (e. g. improved quality and reduced cost of service) which might result from the grant of such authorizations;
- (d) Is it technically feasible to accommodate the space service contemplated, in light of the requirement:
 - (1) That the power flux density produced at the earth's surface in the band 3700-4200 Mc/s by emissions from

a space station employing wide-deviation frequency (or phase) modulation, not exceed -149 dBW/m^2 in any 4 kc/s band for all angles of arrival, nor a total of -130 dBW/m^2 for all angles of arrival;

- (2) That the power flux density produced at the earth's surface in the band 3700-4200 Mc/s by emissions from a space station employing other than wide-deviation frequency (or phase) modulation, not exceed -152 dBW/m^2 in any 4 kc/s band for all angles of arrival;
- (3) That earth stations receiving signals from space stations in the band 3700-4200 Mc/s be so located with respect to the existing common carrier microwave complex in that band that they are not subjected to harmful interference from such terrestrial microwave systems;
- (4) That transmitting earth stations in the band 5925-6425 Mc/s:
 - (a) Not exceed a mean effective radiated power of 45 dBW in any 4 kc/s band in the horizontal plane; and
 - (b) Not cause harmful interference to the existing common carrier microwave complex in the same band.
- (e) Other relevant matters to which the respondents wish to address themselves.

5. It is recognized that the matters raised are unique and complex and the respondents should be afforded adequate time in which to prepare meaningful comments. Accordingly, it is requested that comments be submitted to the Commission by August 1, 1966, and reply comments by October 1, 1966. An original and 19 copies of all comments and reply comments and briefs shall be furnished the Commission. The Commission will consider all such comments, reply comments and briefs, as well as other relevant information before it, prior to taking further action in this matter.

FEDERAL COMMUNICATIONS COMMISSION

Ben F. Waple
Secretary

Adopted: March 2, 1966

Released: March 3, 1966

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C. 20554

FCC 66-926
90132

In the Matter of	)	
	)	
Establishment of domestic	)	
communication-satellite	)	DOCKET NO. 16495
facilities by non-governmental	)	
entities.	)	

SUPPLEMENTAL NOTICE OF INQUIRY

By the Commission: Commissioner Cox voting to add a paragraph restricting consideration to matters on the record; Commissioner Loevinger absent.

1. On September 21, 1965, the American Broadcasting Companies (ABC) requested an authorization in the Auxiliary Radio Broadcast Services to construct and operate a communications satellite system for television broadcast distribution in the United States. We returned the application to ABC without prejudice on March 2, 1966, and adopted on that day a Notice of Inquiry (FCC 66-207) into the questions raised by it, i. e., the compatibility with the Communications Satellite Act, and the technical and economic feasibility of establishing domestic non-common carrier communication satellite facilities by non-governmental entities.
2. Briefs and comments were timely filed by 19 parties on or before August 1, 1966. Among the comments submitted were novel concepts and proposals concerning domestic common carrier service via satellite. In this regard, the Ford Foundation submitted a proposal to create a corporate entity which would furnish satellite facilities for the transmission of commercial and educational television program material, with charges to be made for those services provided to commercial users, and part of the profits and revenues therefrom to be devoted to the support of educational broadcasting. The initial Notice herein expressly limited the scope of the inquiry by providing that it "is not concerned with the question of whether communications common carriers may be authorized to construct and operate communication-satellite facilities for domestic purposes." The Public Notice released September 8, 1966 (FCC 66-799), gave recognition to the necessarily broadened scope of the Inquiry and, our order to afford sufficient time for the preparation of comment on or counter-proposals to the additional matters raised by the filings herein, extended the date for submitting reply comments to November 30, 1966. Finally, provisions were made for the filing of further reply comments on or before December 30, 1966.

3. The purpose of this Supplemental Notice is to clarify the intent of the Commission in its Public Notice of September 8, 1966 as to the nature and scope of the additional matters which interested parties are invited to address in further comments herein. Accordingly, in addition to comments on the proposals and concepts already submitted, comments are invited as to the following matters;

- (a) The Commission desires to have, to the extent they are available, descriptions, from existing carriers responding to this inquiry, as well as other entities intending to seek authority to provide common carrier services, general or specialized, of their plans for using communication satellite facilities to meet domestic needs; and
- (b) Whether, as a matter of law, there is any restriction on the Commission's power to authorize any communications common carrier or carriers to construct and operate communication satellite facilities for domestic communications services;
- (c) Assuming legal authority, under what circumstances should the Commission issue such authorizations, and to whom (one carrier, more than one carrier, two or more carriers jointly), having due regard for, among other things:
 - (1) The comparative advantages of communication satellites and other communication media in meeting domestic communications needs;
 - (2) The effects on charges for, and quality and adequacy of, present and future public communications services;
 - (3) The anticipated volume of domestic communications needs through 1980, and the portion thereof that can and should be satisfied through the use of communication satellite facilities in view of expected technological developments in all media;
 - (4) The comparative advantages and disadvantages of meeting domestic needs (i) through the facilities of the global system; or (ii) through a separate system or systems;
 - (5) The effect or impact of any such authorizations upon the policies and goals set forth by the Communications Satellite Act and upon the obligations of the United States Government as a signatory to the Executive Agreement Establishing Interim

**Arrangements for a Global Commercial Communications
Satellite System.**

- (d) Whether the type of entity and service contemplated by the Ford Foundation proposal may be licensed under present statutes, and, if not, the type of legislation that would be required.

4. For the most part, comments filed thus far have not been fully responsive to the technical questions raised in the first Notice of Inquiry as to the adequacy of existing allocations to the communication satellite service or as to the electromagnetic interference to and from both present and projected operations of the global commercial communication satellite system and the domestic fixed public services sharing the same frequency bands. The latter question is complicated further by the fact that the plenary assembly of the CCIR (Oslo, June 1966), has recommended changes in the technical criteria applicable to the power flux density delivered at the earth's surface from space stations. Therefore, pending resolution of the legal status of the Oslo criteria vis-a-vis those criteria now in the International Radio Regulations, interested parties, in responding to the questions raised in our prior notice and herein (which include the technical questions explicitly set out in our prior notice), should direct their responses to both the present and Oslo criteria. Additionally, to permit an evaluation of the impact from proposed systems, parties should indicate as fully as they now can the planned positioning of space stations on the equator for the system under consideration if equatorial stationary satellites are involved.

5. Reply comments and comments on the above questions should be submitted to the Commission by November 30, 1966, and further reply comments by December 30, 1966. It is requested that an original and 50 copies of all reply and further reply comments be furnished to the Commission by parties filing in this proceeding.

FEDERAL COMMUNICATIONS COMMISSION

**Ben F. Waple
Secretary**

Adopted: October 20, 1966

Released: October 21, 1966

**Arrangements for a Global Commercial Communications
Satellite System.**

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FEDERAL COMMUNICATIONS COMMISSION

Ben F. Waple
Secretary

Adopted: October 20, 1966

Released: October 21, 1966

TABLE CROSS REFERENCING FCC
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Paragraph 4(a)

Discussed at

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4(b)

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4(c)(1)

Vol. III, Part 4

4(c)(4)

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Vol. III, Part 5

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3(c)(4)

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3(c)(5)

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PART 1

INTRODUCTION

The August 1 Proposal and the Role of Satellites

In its August 1 Submission,* the Ford Foundation proposed the creation of a non-profit corporation authorized by the Commission to establish communications-satellite facilities for transmission of commercial and non-commercial television and radio broadcasting. The proposal was intended to help meet the two great needs of non-commercial television -- facilities for a national network, and funds for programming -- and to provide satellite channels for instructional television.

Discussion since August 1 has reminded us again that there is much confusion as to what educational television really is -- and still more confusion about what it should become. We begin by rejecting any narrow or restrictive definition. A very few commentators closely connected to commercial interests have suggested in recent months that educational television should limit itself to instruction -- to programs whose only aim is formal teaching. Fortunately the

* The Foundation submitted two volumes to the Commission on August 1, 1966: Comments of the Ford Foundation in Response to the Commission's Notice of Inquiry of March 2, 1966, and Legal Brief and Comments of the Ford Foundation in Response to Paragraphs 4(a) and 4(b) of the Commission's Notice of Inquiry of March 2, 1966. We here refer to the first volume as "the Foundation's August 1 Comments" and to the second volume as "the Foundation's August 1 Legal Brief." The two volumes together are referred to as "the Foundation's August 1 Submission."

FCC, the Congress, and the major leaders of commercial television have always taken a wider view. Fortunately also, the clear and unchallenged record of what educational television has done shows that such interpretations reflect only the limited vision of those who put them forward.

Educational television has offered programs of instruction and enlightenment, of art and entertainment, defined only by the fact that they are not designed to sell products to people. It should continue to have this breadth as its strength and quality grow. In essence we think it should be provided with the resources to do two things:

first, to provide programs that are not limited by the relentless economic pressure that forces commercial television to concentrate its wealth and energy upon programs that can carry advertising messages to the largest possible number of people. This branch of educational television we call non-commercial television.

second, to provide powerful assistance in raising the capacity of American education to teach our people -- young and old -- (or, more accurately, to assist them in learning). Television can be a major instrument in meeting new demands for quantity and for quality in American education. This branch of educational television we call instructional television (ITV).

Although we find a warm reception to the argument that all forms of educational television need major reinforcement, an argument recently endorsed by the National Science Foundation and the National Foundation on the Arts and Humanities in their comments in this proceeding, when we come to the role of satellites in all this, we find a response that is warm but somewhat uncertain.

People believe strongly in the possibilities of the satellite, but they are not sure just what these possibilities are, or how they relate to non-commercial and instructional television. What will it mean to have access to satellite channels -- as many as are needed, and at no cost?

The quintessence of this meaning of satellites is that they can give immediacy, on a continental scale. They can carry voice and pictures instantly from one place of origin to hundreds of receiving stations with unparalleled breadth, flexibility, and economy. For the non-commercial user they can do these things free, if we want it that way. Other techniques (tape and air mail, or film and projector) can give distribution; the satellite can give immediacy.

Immediacy has a power that we understand too little, because we have used it too little. When we speak of great events -- a President's Inauguration or a major adventure in space -- the power of immediacy is plain. We too easily forget that the same principle of direct and shared exposure to something as it happens -- applies to a much wider set of experiences, and, in particular, to teaching and learning.

One great element of immediacy is that it permits shared experience. People who have seen the same program at about the same time have experienced something more than they would have in wholly separate exposures. The moderns are right: the time to be part of a happening is when it is happening. This is what makes for the heightened intensity of the first night, and for the reinforcing applause on any good night. It is what gives students double reward from a great

lecture -- and doubled comfort in the shared misery of exposure to a bad one. (We sometimes forget that a really bad learning experience -- if shared and recognized -- can teach quite a lot in a highly memorable way.)

The impact of immediacy is as important to the teacher as to the student -- to the artist as to the audience. Sometimes this proposition is taken to mean that first-rate teaching or performing must always be face-to-face, and no doubt there is an immediacy in such physical presence which even the best television can never match. But television has already demonstrated that for larger audiences it is the very next-best thing. The best television commentators -- beginning with Edward R. Murrow -- have had a close and compelling sense of audience; so have the best actors, and a few outstanding politicians. Men who have learned that television is a highway, not a barrier, have demonstrated the power of its immediacy both to themselves and to all who watch. And television also has technical compensations -- it can see parts of the operation that are hidden from others in the operating room, it can get closer to the actor's face than the first-row spectator, and it can join in a single program people who are widely separated.

Satellites can give immediacy. They can give it to teachers and students, to artists and audiences, at levels of quality and variety of which we have no experience whatever in America. They can connect the masters of a subject to thousands of its teachers, in a national seminar. From the beginning they will offer more channels than we are yet certain we know how to use and they will

provide an electronic highway which will serve the new needs of communities of learning and of art that do not yet exist.

There is need for one important clarification. Immediacy does not always require live broadcasting, or even absolutely simultaneous performance on tape, though both are often highly desirable. Educational television can well imitate the commercial networks by using tape for a given program when a better performance results. Danny Kaye is not the less present on Wednesdays -- and he is not less aware of his audience -- because he is taped a little ahead. Similarly, a school TV teaching program will not be less immediate, in real terms, if it is held in a school on tape for a few hours or even a few days so that it can be used where it fits in that school's schedule. The great weekly news magazines are immediate -- and nationally shared -- for several days at a time. There is no sense at all in permitting an appearance of conflict between tape and the satellite. They are reinforcing techniques, and at their best they will marry national immediacy to individual and group convenience.

The Foundation's Premises

The Foundation begins with these premises:

First, non-commercial and instructional television, with their extraordinary potential for affecting the quality of American life, lack adequate resources to do the job. The high costs of long-distance land lines and the costs of improving the quality of non-commercial programs are beyond the resources currently available to non-commercial broadcasting.

Second, communication satellites will distribute television programs at a fraction of the present cost. Since the launching of satellites is the product of the taxpayers' dollar, the taxpayers have a powerful interest in the savings which are possible.

Third, all television and radio broadcasting depend on the use of a valuable, essential and limited public resource -- the electromagnetic spectrum. Access to this resource for profit-making purposes through an FCC license is an extremely valuable right for which the license-holder pays no fee.

The Foundation proposes that a domestic satellite system for television and radio broadcasting be so organized as to return to the people, through improved and expanded instructional television services and through a national non-commercial network with high-quality programs, a small part of their investment in space technology.

The Foundation has no commercial or operating interest in its proposal. It suggests that new institutions be formed to carry the proposal forward. To the extent that part of the job can be done by existing institutions, they will be institutions other than the Foundation. Nor is the Foundation wedded to the specific proposal outlined in the August 1 submission and elaborated here. The Foundation continues to present its proposal as one way, and not the only way, to meet the needs of non-commercial and instructional television.

Our New Technical Models

In the August 1 Submission, we presented two possible models of a

Broadcasters Non-Profit Satellite System -- BNS-1 and BNS-2. In this submission we present two much improved systems -- BNS-3 and BNS-4, based upon the wider and deeper analysis which has been possible in the months since August.

Compared with the earlier models, BNS-3 and BNS-4 are more reliable, more efficient, and more economical in their use of the frequency spectrum. By moving to larger satellites lifted by larger launch vehicles, our designer has been able to propose satellites of greater power and sophistication, each of them carrying 24 channels that can be beamed sharply and powerfully at selected time zones of the United States. The system also includes service omitted from BNS-1 and BNS-2, transmission to Alaska, Hawaii, Puerto Rico and the Virgin Islands.

The new systems are designed to provide the very high level of reliability which the networks desire. They have been tested with the advice of technical experts of more than one company, and their costs have been checked with the assistance of independent analysts.

BNS-3 and BNS-4 are still only models. Like their predecessors, they are open to criticism and subject to improvement. Criticism will be welcome and improvements will be sought. We are persuaded that the two systems are an imaginative and powerful contribution to thinking about domestic television service, and that they take this whole subject a long step forward. The full descriptions of BNS-3 and BNS-4 are contained in Volume III of this Submission.

Events Since August 1

Shortly after the August 1 submissions were filed, the Subcommittee on

Communications of the Senate Commerce Committee held hearings on domestic communications-satellite services, with emphasis on the Foundation's proposal. Senator Pastore presided. Representatives of government agencies, the Foundation, common carriers, and the networks testified. The hearings helped clarify the views of the interested parties and focused attention on areas that needed further study.

During September and October, the Foundation met with the following groups in candid and helpful discussions:

-- Government Officials

We sought the views of officials in the Office of Telecommunications Management, the National Aeronautics and Space Agency, and the Departments of State, Defense, Commerce, and Health, Education and Welfare, because of their responsibilities for and interest in the development of communication satellites.

-- Comsat

We exchanged technical descriptions and cost data of the BNS satellite configuration and the Comsat configuration. We also discussed how many ground stations were needed and the relative economies of BNS and a multi-purpose system, particularly in relation to the demands of non-television users of the satellite.

-- Commercial Television Networks

Our continuing discussions of their requirements with the commercial networks have developed our understanding of such questions as the quality and reliability of service, the technical and economic limitations on present

operations, the flexibility of a properly designed satellite system, and the prospects for growth in network demand.

-- AT&T

With AT&T, we discussed integration of television traffic with general communications traffic, including the services which AT&T and its affiliated companies now provide for radio and television; the costs of a satellite system; and interference problems.

-- Equipment Manufacturers

Discussions here related to the technical characteristics and costs of satellite systems. Two improved systems, BNS-3 and BNS-4, were developed.

-- Panel of Economists

The Foundation invited a group of distinguished economists to explore the BNS concept in terms of the economics of the communication industry, television and regulated industries generally.

-- Educators

The Foundation conferred with educators in a variety of schools, colleges, and universities throughout the country, and others familiar with instructional television. The overwhelming majority stated that instructional television can be and in many cases already is a valuable instrument for learning. They also confirmed what we have long seen as the present inadequacies of instructional television, including the lack of quality programs, the lack of coordination in distributing programs, and the high cost and other difficulties of obtaining programs. A properly

organized communications-satellite system can help meet these problems.

Meeting the Issues

The submissions of the parties, the Pastore hearings, and the Foundation's discussions with others, disclosed four areas of particular interest:

- the possibilities for instructional and non-commercial television,
- potential interference with microwave facilities,
- the cost of providing satellite services, and
- the alternative ways of financing non-commercial television with tax revenues.

The Foundation took special steps to focus on these areas:

-- It retained Professor Wilbur Schramm of Stanford University, a nationally recognized authority on instructional television, to prepare a paper discussing the present state of the art and prospects for the future. That paper appears in Part 5 of this volume, with additional data on the needs of non-commercial television, the potential benefits of a high-quality non-commercial television network, and experience with non-commercial and instructional television abroad.

-- The common carriers and others view potential interference as a serious obstacle to any communications-satellite system. Accordingly, the Foundation commissioned IBM to study potential interference under the most adverse conditions -- a large urban area in a severe rainstorm. The IBM study appears in Volume III, Part 5.

-- To ensure responsible cost projections of BNS-3 and BNS-4, the

Foundation asked the Hughes Aircraft Corporation and Philco-Ford Corporation to prepare cost studies. Independent consultants also provided cost data. The system costs are set forth in Volume III, Part 3.

-- In view of the heavy costs of programming it seems likely that federal revenues will be needed in addition to excess revenues generated by the satellite system. The Foundation asked Mr. Joseph A. Pechman of the Brookings Institution to prepare a brief paper indicating possible sources of tax revenue, alternative means of administering the revenues, and relevant precedents. That paper appears in Part 2 of this volume.

The Carnegie Commission

Some of the issues discussed in this Submission are being studied by the Carnegie Commission on Educational Television and will undoubtedly be treated in depth in its report. We look forward to the Commission's report on the problems of educational television and its view of the possible remedies.

* * *

The Foundation's Submission contains three volumes. In this first volume we direct attention to the wider questions of policy, economics, and opportunity which have been raised in recent months by the FCC and by others. The models of reference in these analyses are BNS-3 and BNS-4, but the basic

principles of organization and of policy to which we address ourselves are independent of the particular performance characteristics of any model.

Volume II focusses on legal issues. Volume III, in addition to describing the technical characteristics and costs of BNS-3 and BNS-4, addresses the problems of interference and adequacy of the frequency spectrum.

PART 2

FINANCING ISSUES

Section a. Potential Savings

Volume III of this Submission describes in detail two satellite system configurations, BNS-3 and BNS-4. BNS-3 has an initial capital cost of \$101.3 million and a level annual cost of \$28.8 million. BNS-4 has an initial capital cost of \$115.8 million and a level annual cost of \$31.8 million.* The annual costs include all commercial, non-commercial, and instructional television distribution requirements, and include also the microwave and cable links necessary to carry the signal from the receiving station to the television studio.

The present cost of interstate radio and television network transmission is about \$65 million.** We estimate that a satellite system operating today could replace roughly \$50 million of this total,*** plus a portion of the annual

* The Foundation's August 1 Comments described two earlier configurations: BNS-1 with a capital cost of \$80 million and a level annual cost of \$19.3 million, and BNS-2 with a capital cost of \$92.6 million and a level annual cost of \$22.2 million.

** Federal Communications Commission, Statistics of Communications Common Carriers for the Year Ended December 31, 1965 (in press). Item No. 55.

*** Precise data are not readily available. We have discussed with AT&T the land line costs that satellites can replace, and believe that the range is \$45 million to \$55 million, with \$50.6 million representing a proper allocation of the switching, operating centers, local channel, and inter-exchange costs of the networks.

cost of present private relay systems. Three factors suggest that this figure will be considerably higher in 1970. First, the requirements for television distribution are expected to increase over the next few years. Second, AT&T has stated that present rates for television distribution are inadequate. Third, a fourth commercial network -- the Overmyer network -- is scheduled to begin operation in 1967 with about 125 affiliates. In time, its distribution requirements should be in line with those of the existing networks. We are advised that transmission costs over land lines for the Overmyer network will exceed \$6 million in the first year of operation.

By 1970, it seems likely that BNS-3 could replace at least \$55 million in annual land line transmission costs for the existing networks and broadcasters plus \$5 million to \$10 million for the Overmyer network, or a total of \$60 million to \$65 million. Deducting the \$28.8 million annual cost of BNS-3 from these figures, we see a potential savings ranging from \$31.2 million to \$36.2 million.

These numbers represent only the potential saving of the satellite system, not its potential revenues. The revenues should be greater because the economies of satellite transmission will stimulate business now precluded by the high costs of land lines. Revenues are discussed in Volume III, Part 3.

Section b. Response to Paragraph 3(c)(4) of the Supplemental Notice of Inquiry

Paragraph 3(c)(4) of the Commission's Supplemental Notice of Inquiry

puts this question:

Assuming legal authority, under what circumstances should the Commission issue such authorizations to construct and operate communication satellite facilities for domestic communications services to, and to whom (one carrier, more than one carrier, two or more carriers jointly), having due regard for, among other things: . . .

(4) The comparative advantages and disadvantages of meeting domestic needs (i) through the facilities of the global system; or (ii) through a separate system or systems.

The central interest of the Ford Foundation in this proceeding is expanding and improving non-commercial and instructional television. The particular route to be followed is considerably less important than the ultimate objective. From the Foundation's viewpoint, therefore, the questions posed by paragraph 3(c)(4) are secondary, not because they lack importance -- they are enormously important -- but because the Foundation is seeking to focus on non-commercial and instructional television, not on related policy issues that primarily concern the Commission and others.

Paragraph 3(c)(4) raises two major issues:

First, whether the public interest is better served by authorizing a single company to provide communication satellite facilities for domestic service or by building competition into the industry.

Second, whether there exist economies of scale so substantial as to offset policies favoring competition.

These are large questions which the Foundation will here address only briefly.

Monopoly v. Competition

To what extent should the Commission seek to preserve the advantages of competition in authorizing domestic facilities for communication by satellite?

The broad alternatives open to the Commission appear to be these:

Refuse to authorize any carrier or other entity in the United States to operate a domestic communication satellite system on the ground that all satellites, whether for international or domestic communication, should be owned and operated INTELSAT as part of a single global system.

Extend Comsat's authorization to domestic communications, granting that corporation a complete monopoly over all United States interests in international and domestic communication satellite services.

Authorize a single entity (one carrier or a combination of carriers) other than Comsat, to construct and operate communication satellite facilities for domestic communication services.

Authorize more than one carrier or other entity (or combination of carriers or other entities) to construct and operate such facilities.

The foreign policy issues raised by the first alternative -- unified control over domestic and international satellite communications -- are dealt with in Part 3 of the Reply Legal Brief. The indications thus far are that a number of countries will wish to maintain the independence and individual integrity of their domestic broadcasting and communications systems. Historically the U. S. Congress has immunized domestic communications from foreign control. The Commission will wish to consider, therefore, whether the establishment of a

single encompassing global system is a realistic possibility and whether independent action by the United States should be suspended pending final determinations in this area. Although domestic satellite services should be technically compatible with the global system, it seems to us unnecessary and unwise to defer domestic developments until all the policies and goals of the global system are clarified.

Even if this country and others were prepared, as a matter of foreign and communications policy, to vest all their domestic communication satellite facilities in an international consortium, substantial issues of national economic policy would remain. The result would be a world monopoly -- one entity responsible for all communication satellite services. There would be no yardstick against which to measure the progress or efficiency of that entity. There would be only one commercial customer for manufacturers of communication satellite equipment. The development of communication satellites and the speed with which improved technology is made available to the public would be in the hands of a single entity. We doubt that such an arrangement would best meet the interests of the American public and the world community in the rapid and efficient development of communication satellite technology.

Issues raised by the second alternative -- a Comsat monopoly of domestic services operated independently of INTELSAT -- are also examined in Part 3 of the Reply Legal Brief. There we discuss possible conflicts of interest that might arise between Comsat's obligations under the 1964

agreements and its obligations to an independent domestic system. If such conflicts materialize they will have economic and foreign policy implications. Again, however, there are two types of problems: potential conflicts of interest and problems of monopoly control over all domestic communications-satellite technology. If Comsat develops a separate domestic system, these problems may be less acute than if there is an integrated INTELSAT monopoly since theoretically, at least, Comsat would operate the domestic system with a separate organization. But it would still leave a single entity as manager and part owner of the international consortium and owner of the domestic system, responsible for the development of all communications-satellite technology.

The general policy of the United States Government favoring competition is based on deeply held convictions

- . that competition fosters private initiative and achievement;
- . that competition is the most effective discipline to promote economic efficiency;
- . that competition is the most powerful incentive for invention and innovation.

In the 1934 Act Congress made a basic policy decision favoring the competitive development of communications services (Sections 313, 314). This policy was applied to communication satellites in the 1962 Act (Sections 102(c), 201(c)(1)). Both statutes reveal substantial Congressional concern about monopolistic practices and the belief that competition is necessary to maintain technological progress.

BNS is proposed as a means of meeting the critical needs of non-commercial and instructional television and not as an instrument of domestic economic policy, but it will assure that at least two independent organizations develop and use communications-satellite technology -- INTELSAT and BNS.

Nor does BNS seek a charter for all domestic communications-satellite services. As proposed by the Foundation, BNS would provide satellite services for television and radio broadcasting, leaving to others the growing needs for satellite services of telephone, telegraph, data transmission, and other forms of communication. Thus BNS, INTELSAT and whatever other satellite systems are authorized, though not competitors in the classic sense, will provide incentives to each other to advance the state of the art and yardsticks against which progress and efficiency can be measured. They will, of course, be technically compatible and organized so as to provide the most efficient and economical use of the frequency spectrum. We believe the public interest will best be served if, as the Foundation proposes, these requirements are met and at the same time monopoly control of satellite technology is avoided.

Economies of Scale

Since the Foundation's August 1 Submission, Comsat and others have suggested that it might be uneconomical to build separate satellite systems, one for television and another for telephone and record services. The claim is made that a multi-purpose satellite system would provide cheaper service for its users.

This argument must be distinguished at the outset from the quite different contention that the cost per channel of a given satellite system will decrease as the total capacity of the system increases. It is of course true, as a comparison of the costs of BNS-3 and BNS-4 indicates, that the cost per channel goes down as the capacity of a given satellite system is increased. But that fact has no direct bearing on the proposition that a multi-purpose system of the kind proposed by Comsat is economically more efficient than two separate systems serving the same needs.

The argument that a service can be offered at a cheaper price if it is offered on a larger scale is appealing since, in many areas, it accords with common sense and with experience. But the real differences in cost between a multi-purpose system and two separate systems are limited. They can be virtually eliminated with minimum cooperation between two separate systems. To the extent that economies do exist they must be weighed against our traditional policy of encouraging competition. These conclusions emerge from an examination of the system described in Comsat's August 1 Technical Plan. (Although we use Comsat's August 1 figures to illustrate the point, the analysis is valid independently of these figures.)

Description of Comsat Model

In its August 1 Technical Plan, Comsat presented a model of a domestic multi-purpose system with the following capabilities:

Full-time television channels	14
Occasional use television channels	10
20,000 message-unit channels (including both point-to-point and multi-point traffic)	12 (TV equivalent)

The satellite segment would contain three satellites of 12 channels each, with no provision for a spare satellite in orbit. The 10 occasional-use channels are regarded as spares available for emergency use if full-time television channels fail.

There would be a total of 117 earth terminals of which the three largest would be used for telephone and television traffic in the New York, Chicago and Los Angeles areas. These terminals would have redundant capabilities, with four 85-foot antennae at New York, four at Los Angeles, and two at Chicago. In addition, there would be six terminals in other communities, capable of receiving both multi-point messages and television. Finally, there would be 108 television distribution terminals, of which 104 would have receive-only capability and four could transmit and receive.

Divisibility of Comsat Model

The service that Comsat would offer can be provided in separate, dedicated systems, at a small increase in total cost.

If the Comsat model were divided into two independent systems, one dedicated to television and the other to message traffic, then we would expect to see no significant added costs in the ground environment. The independent

television distribution system would presumably use the 108 special-purpose television ground stations and part of the physical facilities of the nine multi-purpose ground stations. That part is physically identifiable and readily allocated because the antennae and associated electronics are provided in pairs or quadruples. Telephone and data traffic would use the remaining half of the multi-purpose ground stations as a separate system.

Of Comsat's three satellites, identical and each with a capability of 12 television channels, one would be used full time for television, a second would be used full time for telephone traffic. Two channels of the third would be used full time for television; the other ten channels would be used for occasional television use and back-up purposes. The two satellites concerned with television transmission could be segregated into a single dedicated system. The remaining satellite could be dedicated to message traffic, but an additional satellite would be needed as a back-up.

If the Comsat model is divided into two pairs of satellites (each dedicated to a specific purpose), the primary increased cost is the extra satellite, which, we understand, is calculated by Comsat at approximately \$10 million. There might also be incremental development expenditures with two separate systems, and probably a small increase in administrative costs. On the other hand, there would be offsets because a dedicated television transmission system would not need the 85-foot antennae used by Comsat for its multi-purpose system. Without attempting to assign more precise numbers to these components,

we believe that the extra cost of the dual system may amount to about eight to nine percent of the capital cost of the single Comsat system.

All this is on the assumption that there is no cooperation whatever between the two organizations. If the two organizations, each dedicated to a single purpose, were to cooperate in the R&D costs and were to exchange back-up facilities, the additional cost for authorizing two organizations would be negligible.

Adequacy of Reservation for Non-Commercial and Instructional Service

The argument for a multi-purpose satellite seems largely to depend on an assumption that the demand for television, telephone and other services will mesh with and complement each other. At this time, the assumption cannot be quantitatively verified. We believe that if the argument is valid at all, it is only at the expense of instructional and non-commercial television.

Demand for television is likely to remain reasonably constant during the day and evening hours since requirements for instructional service during the day tend to offset requirements for evening prime-time commercial and non-commercial services. The hours from 1:00 a. m. to 6:00 a. m. could be used to distribute television materials for delayed broadcast or closed circuit distribution.

For long-distance telephone, however, the weekday pattern typically peaks during business hours and again in the early evening hours. These peaks are likely to clash with the demands for classroom and prime-time television use.

Advantages of Specialization

Finally, the emphasis on the economies of a combined system may tend to ignore offsetting advantages including economies of specialization. Telephone or data service requires access to the satellite from any point in the system in order to transmit to any other given point in the system. Television distribution requires access from only one point or a few points, and distribution is made simultaneously to a large number of receiving stations. Television distribution calls for the scheduling of blocks of time; telephone and data service demands are highly variable in time and flow between each pair of points in the system. We think that a single-purpose specialized system, charged with providing good service at a reasonable cost to the television industry, will do a better job for that industry than a system having widespread and potentially conflicting responsibilities to several industries.

The costs of a dedicated system, moreover, would not be buried in a rate base. A number of microwave users today have found it cheaper to own and operate their own system than to buy from common carriers; the savings result from the economies of specialization, with charges based on identifiable, true costs without reference to the rate base requirements of the common carrier.

In television distribution, too, there is movement in the direction of private systems. To quote one study:

"One of the more elaborate systems is the Skyline television network which distributes the programs of

all three national networks to a large area north of Salt Lake City served by eight television stations in Idaho, Montana, and western Wyoming. This system has approximately 1,500 channel miles of television microwave station utilities, none of which is owned or operated by the Bell system. The cost can run as low as \$100 per channel mile per year or less including interest, amortization, and maintenance, which is much below present Bell tariffs."* (Underscoring supplied.)

Possibilities for Joint Use

Whatever the interplay between the economies of scale and the economies of specialization, the issue bears on how physical facilities are used, not on how they are owned and organized. The alternatives are not either a number of special-purpose systems or a single multi-purpose system owned by a common carrier. There are other modes of organization. If there are substantial cost advantages in joint use of some part of the facilities of a television satellite system -- on the ground or in space -- for telephone and data transmission, there is no reason why that should not be done. Joint use of facilities will undoubtedly require foresight in planning and designing the satellite system to insure flexibility; it will also require ingenuity in developing joint uses or forming joint ownership arrangements. We believe, however, that national economic tradition, the heavy national investment in space, the bright promise

* Hammett and Edison, "Television Satellite Systems: An Estimate of Present Requirements and Future Growth," (A Report Prepared for the Ford Foundation), page 3.

of satellite technology and the compelling needs of non-commercial and instructional television obligate us to look beyond traditional responses, as the Commission has done before.

In American Telephone and Telegraph Co., et al., 37 F.C.C. 1151 (1964), the Commission found that a fourth transatlantic submarine telegraph cable of the type proposed by AT&T was required by the summer of 1965. Competing applications were before it but the Commission concluded that the cable "should be owned jointly, and should be authorized in the name of all of the U. S. overseas telecommunication entities, both record and voice, which desire to participate in such ownership" (37 F.C.C. at 1161). AT&T had offered to allow the record carriers ownership in the proposed cable and this compromise was agreeable to the competing parties. Ownership interests were to be in such proportions "as may be agreed to, subject to Commission approval, by and among all of these carriers in accordance with their current and reasonably foreseeable traffic requirements, or, if no such agreement is able to be reached, as determined by this Commission" (37 F.C.C. at 1157). Similar solutions are available for satellites, if warranted.

Section c. How Lower Costs of Satellite Transmission will be Reflected
in Rates if the System is Owned by a Common Carrier

It is clear that dramatic cost savings are possible with satellite transmission. Under the BNS proposal, these savings can be identified and shared between non-commercial television and commercial users of the satellite system. How they will be shared is a matter for the interested parties to work out. An allocation formula will have to be spelled out at the beginning, and commercial users will need assurances against capricious or unreasonable changes. But the important point is that all of the savings can be put to use.

If the satellite system is operated by a common carrier, the savings are likely to be absorbed and passed on to users, if at all, in amounts too small to be noticed. The effect on charges of common carrier operation are discussed in the following statement prepared for the Foundation by Dr. Leland L. Johnson, an economist specializing in rate-making problems of regulated industries.

Communications Rates and Integrated
Communications Systems

by Dr. Leland L. Johnson*

In a competitive economy we ordinarily assume that introducing a new cost-reducing technology will bring about a commensurate reduction in price to the user and discourage further investment in the older technology. However, in the case of government regulated firms, such as telecommunications common carriers, the impact of new technology may vary substantially from the competitive norm. More specifically, the use of satellites by a common carrier could have a delayed and relatively small impact on rates paid by users.

If AT&T were to introduce satellites for television distribution (perhaps in conjunction with telephone and data service), the investment would presumably be added to AT&T's existing investment in interstate telecommunications facilities as part of the rate base on which AT&T's rate of return is regulated by the FCC. If the system is introduced by Comsat, the result is likely to be the same since the FCC has so far authorized Comsat to deal only with common carriers and not ultimate users. In general, the FCC does not regulate rates for individual services to reflect closely the costs

* Dr. Johnson received his Ph.D. degree from Yale University and served on the Yale Economics faculty. His publications include an article, "Behavior of the Firm Under Regulatory Restraint," and the monograph Communication Satellites and Telephone Rates: Problems of Government Regulation.

of those services. Rather, it has been primarily concerned with the return on AT&T's overall investment directed to interstate operations. Though the situation has changed somewhat in recent years, the company has been given considerable latitude in setting rate levels for individual services, subject to the overall constraint that the total net revenues from all its interstate services taken together must not exceed a "fair" return on investment. Under these conditions the introduction of a satellite system for television and/or telephone use would tend to have little effect on rates charged for these specific services, since the satellite investment would be only a small part of the overall investment against which AT&T's profits are measured.

The situation can be illustrated by the hypothetical and highly simplified example on the following page.

	Existing Plant and Equipment (Output 500 Units)	New Plant and Equipment (Output 50 Units)	Existing Plus New Plant and Equipment (Output 550 Units)
Investment (Current book value)	\$ 2,000	\$ 100	\$ 2,100
<u>Current Costs</u>			
Amortization	200	10	210
Fair rate of return (9% of investment)	160	9	169
Operating cost	200	10	210
	<u>\$ 560</u>	<u>\$ 29</u>	<u>\$ 599</u>
Cost per unit of output	\$1.12 ^a	\$1.58	\$1.07 ^b

a. With existing investment, price per unit of output to cover cost is \$1.12 (\$5.60÷500 units of output).

b. With existing investment plus new investment, price per unit of output is \$1.07 (\$5.99÷550 units).

In this case, the unit cost of the new technology is only half the unit cost of the old; yet the price per unit of output to cover the cost of the new investment mixed with the old falls from only \$1.12 to \$1.07 or by less than 5 percent. Much of the cost reduction afforded by the new technology is passed on to the users of the older technology through the across-the-board 5 percent reduction in price.

In a competitive industry the results would be considerably different. The price could not be maintained at \$1.12 or \$1.07. So long as competitors

were free to introduce the new technology and charge prices as low as \$.56 (to reflect fully the reduction cost), the firm holding the original investment would also have to charge the lower price.

But why, one might ask, does not the FCC ensure that rates for individual services do reflect the costs involved in rendering those services, rather than focusing primarily on AT&T's overall rate of return. In recent years the FCC has attempted to do precisely that. Several years ago it ordered AT&T to separate out the cost of its overseas services from its domestic interstate services in order to examine the appropriateness of AT&T's overseas rate structure. The FCC has also undertaken a long and complex "Telpak" investigation involving a separation of costs for this high speed data transmission service; and it has been involved from time to time with other cost separation studies, particularly relating to AT&T offerings directly competitive with Western Union and other common carriers.

However, these attempts to separate out costs for individual services all face one quite serious and fundamental problem -- the existence of joint costs which necessarily introduce an arbitrary element in the allocation. For example, a microwave tower can be used for a wide variety of services including telephone traffic, data transmission and television distribution. How should the investment and operating cost of that tower be allocated? Clearly enough, each service should be charged at least enough to cover the additional or incremental cost that the service imposes on the tower construction and operation.

For instance, if data transmission imposed the additional requirement that the microwave repeater have a more complex design than would otherwise be the case, the additional cost should be charged to data transmission. The difficulty is that once we have taken into account all such clearly identifiable cost components of the microwave tower, some costs still remain to be allocated as a kind of overhead among all these services. Unfortunately, there is no fully satisfactory way to treat the remainder, and the remainder is normally discable. A number of principles could be used to allocate these costs among the separate services, but all of them involve arbitrary judgments about who should pay more and who should pay less.

The existence of joint costs explains the focus on overall returns on investment and the substantial latitude that AT&T has to fix individual rates. While one might argue that certain people are forced to pay more than they "ought" to pay for particular services, the presumption is that these people are nevertheless paying less than they would if they had to supply the services for themselves or if they were buying from competitive firms operating wasteful, duplicating facilities.*

The problem of joint costs is more severe in some cases than others. For example, separating overseas telephone costs from the rest of AT&T's

* The problem of allocating joint costs, particularly as they relate to communications satellites, is discussed in greater detail in L. Johnson, "Joint Cost and Price Discrimination: The Case of Communications Satellites," *Journal of Business*, January 1964.

operations is fairly straight forward. While overseas service does share local landlines, switching facilities, etc., with domestic local and long-distance service, AT&T's underwater cable and radiotelephone facilities represent a large and distinguishable component of overseas costs which are readily separable from domestic facilities. Consequently it does make sense for overseas costs to be separated from domestic, with AT&T held to a fair rate of return on each service taken alone. Instances have arisen, too, where individual firms have found it cheaper to install communications services for their own use, or with use in cooperation with other firms, rather than to purchase services from common carriers. Many such private activities have been approved by the FCC (especially as in outgrowth of the "private line" case a few years ago. By and large, however, the element of joint cost is too large to permit an economically sound break-up of domestic common carrier operations.

A common carrier system that leases services to other carriers, as Comsat now does, faces the same problem. The rates charged to users of the satellite would depend on the allocation of joint costs including a portion of long distance landline networks employed as a backup to the satellite system. When the telephone user (and perhaps the television customer) does not know whether his signal is carried on cable, microwave relay lines, or the satellite, the prospects of rate reduction from the new technology are doubtful. Given the likely large element of joint costs involved, the cost reductions afforded by satellites could be largely lost in the shuffle -- at least until the satellite system grows to a point where it becomes a relatively large part of total costs.

Section d. Possible Tax Revenues for Non-Commercial Television

While a BNC system can produce free channels and important funds for television programming, it has been apparent from the first that educational television as a whole has still larger needs. As a part of its studies of these matters, the Foundation in September commissioned Dr. Joseph A. Pechman to prepare a memorandum on the alternative possibilities in this field. The Foundation takes no position on Dr. Pechman's conclusions, but the importance of the subject leads us to include his memorandum, which follows, in this Submission.

Possible Tax Revenues for Non-Commercial Television

by Joseph A. Pechman *

This memorandum presents alternative methods of financing a strong and effective non-commercial television system. It is assumed that total financial requirements will probably be in the order of \$200 million annually and that half this amount might be raised by the system itself, through local philanthropy and revenues from a DNS system. This would leave \$100 million to be raised from other sources. Since the benefits of non-commercial television are widely diffused and there is no practical way to allocate them among the beneficiaries through the market mechanism, it is appropriate to finance the remainder from public (i. e., federal) sources. Section (1) discusses the types of taxes or user charges that might be levied, and Section (2) discusses the techniques to funnel these receipts to a non-profit system.

(1) Sources of Funds

There appear to be two major sources that might be used for this type of financing: first, the gross receipts or profits of the broadcasting industry; second, taxes or contributions by users and beneficiaries.

* Dr. Pechman is Director of Economic Studies at the Brookings Institution, on leave as Irving Fisher Research Professor of Economics at Yale University. His previous affiliations include the Massachusetts Institute of Technology, the Office of Tax Analysis in the Treasury Department, the Council of Economic Advisors, and the Committee for Economic Development. He received his Ph. D. degree from the University of Wisconsin. Dr. Pechman has written widely on taxation and economic policy issues. His most recent book is Federal Tax Policy, a volume in the Brookings Program of Studies in Government Finance, which he directed.

Use of the first source would be justified on the ground that the federal government has provided substantial benefits to the broadcasting industry and to radio and TV owners by permitting the industry to use the broadcast spectrum and by financing large public investments which have already improved the technology available to the industry. Taxation of the industry (and the users of its services) could be regarded as a charge for the benefits of frequency allocation and interference control which are essential for effective broadcasting. Moreover, profits have grown rapidly in recent years (Table I), suggesting that the benefits conferred on the industry by government regulation, including access to the frequency spectrum, and investment have generated an element of "monopoly" profit. It would be appropriate to tax such profits for public purposes unless it can be shown that rates of return are competitive (in the sense that they are at a minimum needed to draw capital to this activity).

(a) Charges on the broadcasting industry

Total revenues of the broadcasting industry (radio and TV combined) were already in excess of \$2.75 billion in 1965, and profits before taxes were about \$570 million (Table I). Both have been growing rapidly in recent years, the former at an annual rate of 10 percent since 1960 and the latter at almost 20 percent. Assuming a conservative increase of 10 percent in profits as well as revenues, the picture for 1967 would be as follows:

<u>Item</u>	<u>Amount, 1967 (millions)</u>
Revenues	\$3,334
Expenses	<u>2,647</u>
Profits before tax	<u>\$ 687</u>

With broadcast revenue approximating \$3-1/3 billion, a 3 percent gross receipts tax would be just enough to raise \$100 million at 1967 levels of activity. Such a tax would not be onerous under current and foreseeable conditions. It would doubtless be shifted fairly promptly in higher charges to advertisers, who would in turn attempt to recover the tax by shifting it forward in the form of higher prices to their consumers. Since the products of TV and radio advertisers are widely consumed, the tax would eventually be borne by most consumers. Even if as much as a third of the tax were not shifted and had to be paid out of the industry's profits, after-tax profits would not be greatly affected. Profits before tax would be reduced by \$33 million; but at a 48 percent rate for the corporate income tax, \$16 million would be paid in the form of reduced federal taxes. The net burden of \$17 million would amount to about 5 percent of estimated 1967 net profits after tax.

The shifting of taxes to the general public to pay for the benefits the public receives from richer television fare can readily be justified. Ideally, of course, user charge for such improvement should be levied in proportion to the benefits, but there is no basis for making such measurements. The benefits of non-commercial television will accrue to the general population through the development of cultural values, improved education, and a more informed electorate. Such "externalities" cannot be sold in the market place and should be paid for out of taxes levied on the beneficiaries. In this particular case, since about 95 percent of the nation's households have at least one TV set and all children

stand to benefit from the improved educational facilities, the beneficiaries of non-commercial television cannot be distinguished from the general taxpayer. Even non-users will benefit from non-commercial television and from the wider range of potential choice of programs it will promote.

Some suggestions have been made that instead of a gross receipts tax, a special tax on the industry's profits may be warranted. However, it would probably be impractical to raise \$100 million in this way. This would amount to almost 15 percent on profits before tax, which would be inordinately high considering that the industry already pays a regular corporation tax rate of 46 percent. The tax on gross receipts of the broadcasting industry would have the advantage of imposing a smaller (but not identifiable) burden on the industry's profits. The impact of a special profits tax could perhaps be moderated by permitting the industry to apply part or all of it as a credit against its present federal corporation tax liability, thus retaining the total profits tax burden at 46 percent. But earmarking portions of the corporate income tax in this way would be a bad precedent, and subject to legitimate criticism by the Treasury and others seeking to protect the income tax from further erosion.

(b) Charge on all FCC long-distance communications licensees

The base of the gross receipts tax could be broadened -- and the rate commensurately lowered -- by applying the tax to the revenues of all commercial FCC licensees involved in long-distance telephone calls and domestic and overseas telegrams, as well as radio and TV revenues. The base of such a tax already

exceeded \$8 billion in 1965 (Table II) and will approach \$10 billion in 1967.

A 1 percent tax would therefore raise the required \$100 million.

There is already a precedent for the use of a low-rate excise tax to pay for a federal service. On January 1, 1969, when the last vestiges of the Korean War excise taxes expire, the auto manufacturers excise tax (now 7 percent and scheduled to be reduced to 2 percent on April 1, 1968) will be maintained at 1 percent to pay for research in auto safety. The telephone tax (now 10 percent and scheduled to be reduced to 1 percent on April 1, 1968) will expire on January 1, 1969 under present law. To help finance non-commercial television, it would be necessary merely to keep the tax on toll telephone calls permanently at 1 percent and to extend it to telegraph and broadcasting revenues.

The tax on long-distance communications is less readily defended on the "monopoly profits" issue than the tax on broadcast revenue. But there is a satisfactory rationale. The broadcast revenue tax is also based on the notion that through shifting of the tax the users of non-commercial television would pay for its cost. This is even more true of the broader communications tax, which would be paid by all or most of the nation's citizens either directly or indirectly through higher prices for products of firms using long-distance communications and broadcasting facilities. The tax on all long-distance communications revenues can also be justified on the ground that these users will be among the major beneficiaries of the satellite technology developed by the federal government. The government could hardly be criticized for attempting to recover a small part of its investment from these beneficiaries.

(c) Tax on users

A tax on the users is the most direct method of financing non-commercial television. There are two possibilities: (1) a flat license fee to be paid by all households with at least one radio or TV set; and (2) a manufacturers excise tax on the sale of radio and TV sets. The fee or excise tax approach assumes that sets are widely owned (which they are) and that the externalities of non-commercial television will benefit the public irrespective of the use they make of non-commercial television. In addition, such charges would help pay for the subsidy now provided to set owners who are spared the higher TV set prices that would result from more intensive use of the broadcast spectrum.

Since there are already more than 50 million households with radios and TV sets, an annual license fee of less than \$2 per year per household would raise the necessary \$100 million. This method has been used successfully in the United Kingdom. Although the charge would be nominal, it would be highly unpopular in the United States. Moreover, the cost of collection would be out of proportion to the amount collected.

The alternative method, which is probably more acceptable to the public and administratively more efficient, would be to tax the sale of radios and TV sets by manufacturers. (A retail tax would be feasible but relatively costly to administer since the number of sales outlets is very large relative to the number of manufacturers.) A 10 percent tax on most household durables was levied for many years in this country, but it was repealed along with most of the other

selective excise taxes in 1965. The value of manufacturers' shipments of radios and television sets was \$1.9 billion in 1964 (Table III) and will almost certainly exceed \$2 billion in 1967. A 5 percent tax would therefore raise \$100 million.

(2) Organizational Arrangements

Funds collected through internal revenue taxes go into the general Treasury, unless the legislation prescribes that the tax shall be paid into a trust fund. Such funds are established to account for receipts that are held by the federal government in a fiduciary capacity for use in carrying out the specific purposes stipulated in the originating legislation. The trustee relationship is considered to be irrevocable by the federal government.

The major advantage of the trust fund device is that payments out of the fund are made without going through the annual appropriation process. Although budgetary experts argue that it should be used sparingly, the trust fund is particularly appropriate for an activity such as non-commercial television. Programming for non-commercial television must provide maximum freedom for the artists and other participants. If funds were subject to annual appropriations, Congressional control and interference would be an ever-present danger. Freedom from the political process is an essential ingredient for the success of non-commercial television.

There appear to be no legal obstacles to the creation of a federal trust fund to provide support for non-commercial programming operated as a private

non-profit organization. Although there are no precedents among the trust funds, the federal government already appropriates funds from the administrative budget to numerous non-profit organizations, including Howard University, Gallaudet College, and other similar institutions. (Table IV gives a partial list of such organizations and actual and estimated expenditures by the federal government in fiscal years 1965-67.) Federal expenditures for these institutions, which are administered by private boards of trustees, will exceed an estimated \$26 million in 1967.

The legislation to set up the trust fund could be relatively simple. It would appropriate an amount equal to the taxes collected (net of refunds) to the trust fund, and permit the transfers of such funds under permanent and indefinite appropriations. The fund in turn would have permanent authority to transfer the funds to the appropriate organization. The tax or taxes to be used could be imposed in the same legislation, or legislated separately.

(3) Summary

The following listing summarizes the five taxes that might be used to finance non-commercial television approximately in order of preference. In ordering the various taxes, consideration was given to political practicability and administrative feasibility, as well as to equity and economics.

The 1 percent tax on all long-distance communications heads the list, but the 3 percent tax on broadcasting revenues and the 5 percent manufacturers

excise tax on radios and TV sets are not very far behind. The annual \$2 household license fee and the 15 percent tax on broadcasters' profits are definitely inferior to the other possibilities.

<u>Type of Tax</u>	<u>Base (millions)</u>	<u>Tax Rate</u>
1. Tax on gross receipts of all long-distance communications	\$10,000	1%
2. Tax on gross receipts of radio and TV broadcasting	3,334	3%
3. Manufacturers excise tax on the sales of radios and TV sets	2,000	5%
4. License fee on all households with radios and TV sets	50	\$2
5. Tax on profits of radio and TV broadcasters	687	15%

TABLE I

Revenues, Expenses and Income of the Radio and
Television Broadcasting Industry, 1955, 1960, and 1965
(millions of dollars)

Year	Revenues	Expenses	Income before tax
<u>Television</u>			
1955	745	595	150
1960	1,269	1,025	244
1965	1,965	1,517	488
<u>Radio</u>			
1955	452	406	46
1960	592	544	48
1965 ^a	790	710	80
<u>Radio and Television</u>			
1955	1,197	1,001	196
1960	1,861	1,569	292
1965	2,755	2,227	568

Sources: Statistical Abstract of the United States, various issues, and
Federal Communications Commission, TV Broadcast Data - 1965,
(mimeograph, dated August 2, 1966).

^aEstimated on basis of 1964 data.

TABLE II

Revenues of Commercial FCC Licensees Involved
in Long-Distance Communications, 1955, 1960, and 1965
(millions of dollars)

Type of communication	1955	1960	1965
Toll telephone	2,049	3,148	5,000 ^a
Telegraph -- domestic	229	262	315 ^a
Telegraph -- overseas	36	87	120 ^a
Radio broadcast	452	592	790
TV broadcast	<u>745</u>	<u>1,269</u>	<u>1,965</u>
Total	3,511	5,358	8,190

Source: Statistical Abstract of the United States, various issues, and
Federal Communications Commission, TV Broadcast Data - 1965,
(mimeograph, dated August 2, 1966).

^aEstimated on basis of 1964 data.

TABLE III

Value of Manufacturers' Shipments of Household
Radio and Television Receivers, Phonographs
and Record Players, 1955, 1960-64
(millions of dollars)

Year	Amount
1955	1,508
1960	1,223
1961	1,279
1962	1,399
1963	1,538
1964	1,805

Source: Statistical Abstract of the United States, various issues.

TABLE IV

Selected Private Non-Profit Organizations Receiving
Payments from the Federal Government and
Amounts Received, Actual 1965, and Estimated 1966-67
(thousands of dollars)

Name of organization	Fiscal year		
	1965 actual	1966 est.	1967 est.
American Printing House for the Blind . . .	865	1,000	1,028
National Technical Institute for the Deaf . .	--	352	335
Freedmen's Hospital	3,929	4,500	4,900
Gallaudet College	4,356	3,545	2,977
Howard University	<u>11,618</u>	<u>15,105</u>	<u>17,600</u>
Total	20,768	24,502	26,840

Source: The Budget of the United States Government for the Fiscal Year Ending June 30, 1967, pages 261-62.

PART 3

ORGANIZING THE SATELLITE SYSTEM, NON-COMMERCIAL NETWORK OPERATIONS, AND PROGRAMMING

Introduction

The Foundation's August 1 Comments suggest that a properly organized television satellite system can help to meet the vital needs of non-commercial and instructional television. We here consider some of the major organizational issues implicit in the Foundation's approach.

These suggestions represent our best current thinking, but they are necessarily tentative. There exists a wide range of acceptable organizational arrangements, but many of the considerations bearing on the final choice will only emerge as understanding of the substantive issues matures. To this understanding the Carnegie Commission will unquestionably contribute. Final determinations must reflect the values and traditions of the country at large.

Meanwhile, it is important for analysis and discussion on organizational issues to proceed at the same time as consideration of the other questions -- technical, operational, financial -- involved in these proceedings. Study can best proceed in the context of concrete proposals for the organizational framework of the enterprise.

Major Functions

Three major functions are involved in the Foundation's proposal:

1. Operation of a communications satellite system to serve both commercial and non-commercial networks and stations;

2. Operation of a national network of non-commercial -- ETV -- stations;
3. Receipt and disbursement of funds for the development of improved educational, cultural and informational programs.

A basic question is whether these three functions should be combined in a single organization or whether they should be divided among separate entities.

The argument for consolidation is clear. Satellite operations, network management, and programming are interrelated. Working relations must be close and continuous. A single organization would reduce overhead costs and administrative burdens.

Yet there is a tradition in this country against giving an operator of communication facilities a significant measure of control over content. It may be undesirable to concentrate power of this sort in a single organization even though regulatory safeguards can be devised. Allocating the functions to separate organizations, each responsive to different interests and pressures, may build useful checks and balances into the system. Finally, although the three functions are interrelated, they are distinct. Different skills and structures are necessary for each. At the present stage of our thinking, we therefore conclude that the full development of a non-commercial television system will probably require three separate organizations.

Satellite operations, network operations, and fund disbursement are each discussed in the sections that follow. For satellite operations, we present

an organizational model. We do not do so for network operations or fund disbursement in view of the forthcoming report of the Carnegie Commission, which has given special attention to these matters.

1. Satellite Operations

a. Functions

The operation of a domestic communication satellite system includes:

- establishing and operating a system of synchronous communication satellites;
- providing ground-station facilities for commercial and non-commercial users;
- conducting and monitoring research on new developments in satellite and ground-station technology;
- leasing the channels to commercial users;
- encouraging experimental uses of television for non-commercial purposes;
- setting charges that will generate revenues for non-commercial programming (Federal Communications Commission regulation of rates is discussed in Volume II, Part 4).

b. Ownership

These functions could be performed either under government ownership, by a private profit-making corporation, or by a private non-profit corporation.

Since satellite and launch technology are almost entirely a product of government-financed research and development, government ownership of a domestic television system would seem to be particularly

appropriate. The taxpayers' investment in space technology is in the billions of dollars. Government ownership would make the benefits available to all the people at minimum cost whereas a privately owned satellite system would channel profits from this investment to a limited number of stockholders.

The system we have suggested would contribute substantially to American education, which is a proper concern of government.

There is ample precedent in this country for government ownership of some enterprises in an industry dominated by private concerns. The most obvious example is the Tennessee Valley Authority, a government corporation chartered by the Congress. The Panama Canal Company, an agency of the United States Government, operates the Panama Canal and conducts business operations incident to the maintenance and operation of the Canal and to the civil government of the Canal Zone. The St. Lawrence Seaway Development Corporation, The Federal Deposit Insurance Corporation, the Export-Import Bank of Washington, and the District of Columbia Redevelopment Land Agency are other examples. The list of special-purpose government corporations is long.

A private, profit-making corporation could, of course, operate the television satellite system. Indeed, in 1962 the decision was made to use a special version of that form for the United States participation

in international satellite communications. But there the direct public service features were considerably less important than in domestic non-commercial television.

A private corporation organized for profit would have difficulty generating excess revenues for programming. It would pay taxes; it would be obligated to earn a fair return for its stockholders; it would be bound by law to serve the interests of its stockholders -- which may not be those of the nation at large.

Given the taxpayers' investment in space and satellite technology and the importance to the nation of non-commercial television, both in the instructional field and ETV, the domestic television satellite system should be directly responsive to national interests. Extensive safeguards and regulations would be required to insure that the needs of non-commercial television -- free channels and a substantial contribution to the costs of programming -- are met through a private, profit-making organization.

A non-profit corporation would be a wholly acceptable alternative to government ownership and is more consistent with the U.S. tradition of private ownership of communication facilities. It would have operational flexibility. It could act pro bono publico and would have no conflicting obligations to stockholders. The interests of the government would be insured by proper representation on the Board of Directors and by the regulatory power of government agencies.

c. A Model - Broadcasters Non-Profit Satellite Corporation (BNSC)

If a private, non-profit corporation is the preferred form, it could be chartered, without legislation, under one of the existing state, non-profit corporation codes. BNSC would be jointly sponsored by the commercial and non-commercial institutions engaged in broadcasting. Its charter would establish the terms and conditions of participation and authorize the corporation to perform all functions necessary for satellite operations. All interested parties would participate in drafting the charter.

We believe that commercial banking sources will make capital available to BNSC. Cost projections for the satellite system, set forth at Volume III, Part 3, are based on commercial financing terms. Financing may also be available from commercial users of the system. It is conceivable that initial financing might be arranged to eliminate part of the normal costs of obtaining money.

BNSC would be governed by a board of trustees, which should include representatives of all interested parties, including the networks and television stations. The charter might also provide for public trustees, as does the Comsat legislation, and for representation of government interests (congressmen, cabinet members, representatives of state and local governments, etc.). Procedures for choosing the board would be spelled out in the charter.

Initially BNSC will require a relatively small staff of engineers and contract managers to negotiate and monitor contracts. The staff will also include financial, legal and marketing specialists.

Such a corporation could be established quickly. The rapid development of the sophisticated aerospace, electronic, and communications industries during the past 25 years insures that highly skilled organizations and management are available to provide first-rate contractual services and facilities.

During the lead-time required to prepare specifications, let contracts, and procure the equipment, BNSC could expand its staff and facilities to include the skills and equipment necessary to operate the system.

BNSC could be either a specialized common carrier or a cooperative. See Volume II, Part 4.

It could be the sole owner and operator of a domestic television satellite system or a participant in a joint venture operating a system of broader scope. If a multi-purpose system were established, a joint venture similar to INTELSAT might be formed in which BNSC represents the television users and Comsat, AT&T, or some other entity represents other users.

2. Network Operations

a. Functions

The history of the commercial networks demonstrates the dramatic impact of national networks on programming and on the economic vitality and growth of commercial television and local stations.

The new communications-satellite system would enable non-commercial stations to form a similar national network. The technical interconnection of the non-commercial stations would be achieved without cost to the local stations via the satellite system.

The new national network would be in a position to purchase or produce first quality educational, cultural and informational programs for transmission over local ETV stations, thus reducing the program costs for each ETV station and providing a source of live programs of professional quality to increase their audiences and sources of local support.

There is one important difference between the network function as now performed by commercial networks and the function as it would be performed by a non-commercial network. The market place determines the programs that commercial networks select for distribution. A non-commercial network would have to make similar decisions

without the laws of supply and demand to guide it. We believe that a national non-commercial network should work in close cooperation with panels and commissions representing geographic areas, the performing arts, public affairs, and similar interests to assist it in deciding what programs should be made available to non-commercial stations.

b. Special Problems of ITV

The non-commercial network would perform similar functions for ITV, but the relation of the network to ITV is especially sensitive. We see two vital principles:

First, the new network should not infringe on or in any way restrict the traditional responsibility of state and local education authorities to control the curriculum and the educational content of instructional materials used in the school system for which they are responsible. It is these local authorities who will decide what programs go into the local schools. The central objective of proposed experiments with national ITV programming would be to widen the area of choice and to increase the availability of educational programs and materials of high professional quality to these school systems.

Second, a national network would by no means have a monopoly of the development of ITV programs. Any interested agency or group

could develop instructional programs or series for use on television -- universities, schools of education, local school systems, or individual schools. A prime source of programs might be private educational companies, either non-profit or profit-making, that would develop and produce educational materials for television in much the same way that such enterprises produce educational materials today for conventional instructional methods -- textbooks, film strips, laboratory equipment and the like. Producers of such programs would be eligible for financial support from the pool of funds allocated for program development. The network would provide channels for these programs in accordance with the demand they generate from state and local school systems.

We believe that a national non-commercial communications-satellite network could greatly accelerate the development of new, high quality instructional programs for the schools. The essential contribution of the network would be to spread the heavy development costs of ITV programs over many school systems, and to draw on a much larger pool of creative talent than is available to any single system.

The network staff concerned with the development of ITV programs for the non-commercial television network would work closely with representatives of educational and scientific organizations, with local school officials, with the universities, and with the educational

publishers to develop, to experiment, and to test new teaching materials and programs suitable for national broadcast to the schools.

The national ITV programs could be designed for live broadcast in those schools that elect to use them as a basic part of their core curriculum. The national programs could also be used for remedial instruction or for teacher-training programs where they were appropriate. The network could enrich local school curricula by making available live or taped broadcasts of national news programs and cultural programs and by stimulating higher standards of teaching performance.

c. Ownership

The network function is the most sensitive component in the system since it determines what programs have access to the satellite and thus the viewer's range of choice. It is hard to conceive of a private, profit-making corporation operating a network composed of non-profit educational television stations. We believe there would be a widespread public preference for operation by a private, non-profit corporation rather than government control.

3. Program Fund Disbursement

We see at least three sources of funds for non-commercial programming: excess revenues generated by the operation of the satellite system, general philanthropic support, and tax revenues.

Non-commercial programs now originate primarily with local ETV stations and NET. Substantial increases in program funds would enable the resources of commercial networks, stations, and independent producers to be tapped. It would permit new sources of talent to be employed in newly established local, state, and regional programming centers, and permit the establishment of television centers for the analysis of public affairs and events of national and regional importance. In short, with increased funds, non-commercial programming would gain in diversity and plurality of sources. The organization of fund disbursement is a question within the province of the Carnegie Commission; we look forward to its recommendations.

PART 4

A NATIONAL TEST SATELLITE PROGRAM

A number of questions have been raised regarding the feasibility and consequences of the Foundation's proposal and the Comsat Technical Plan.

The common carriers claim that domestic communication satellites will interfere with terrestrial transmission unless the number of ground stations is small. Our studies, including the IBM study published in Volume III of this Submission, indicate the contrary, but we appreciate the importance of the problem to AT&T and others.

The responsible officials of the FCC, the Office of Telecommunications Management and other government agencies are increasingly concerned by growing demands on the frequency spectrum.

The domestic networks, who will be the primary users of a domestic satellite system, desire reassurance regarding the feasibility and reliability of the switching and interconnection services they will require.

While the Foundation believes it would be in the public interest for the Commission to authorize BNS-type operations without delay, we understand from discussions with the FCC, NASA, OTM, Comsat and others that serious thought is currently being given to the possibility of launching a test satellite. If a test program is undertaken, it should be conducted so as to minimize delay in the establishment of a domestic communications-satellite system.

The Foundation assumes that a test program designed to measure interference within the allocated frequencies, to determine the most efficient use of the frequency spectrum and to test commercial and non-commercial network

operations and instructional television would be administered by the government, in cooperation with private interests. We believe that NASA best satisfies the need for objective, disinterested management. Other federal agencies that would presumably participate in the program include FCC, OTM, HEW, DOD, and the National Bureau of Standards of the Department of Commerce; the private interests include the carriers, the networks, Comsat, the satellite system manufacturers, and the private foundations concerned with non-commercial and instructional broadcasting.

The Foundation is keenly aware of the burden that the management of such a program would impose on NASA. It is outside the scope of NASA's presently planned activities. It might require several years of work. Generous support from the Congress would be vital since substantial funds not otherwise available would be required. Yet the reward would be great. The demonstrated technical and managerial capacity of NASA and its central role in the civilian space program would provide powerful assurances of the validity of the findings, and the involvement of NASA would help dramatize for the nation the enormous benefits that the space program can offer to our children and to ourselves.

NASA could also enable a swifter beginning to be made in demonstrating the potential of non-commercial and instructional television. With the Application Technology Satellites Series (ATS), NASA is already engaged in a testing program. The first spacecraft has just been launched and subsequent launches are called for approximately every six months up to and including a fifth launch. In the ATS Series there are spin-stabilized satellites.

(ATS-B and ATS-C) which may be free for other test uses by mid-1967. We believe this spacecraft could probably be used for some interference testing and could almost certainly be used for early pilot operations of non-commercial and instructional television through the satellite.*

We understand that there are other advanced ATS programs scheduled for the 1969-1970 time period whose form can probably be modified to accommodate not only their presently planned missions but also the additional measurements required to determine whether the satellite signals will interfere with terrestrial facilities.

The Foundation strongly recommends that existing programs and existing spacecraft be used wherever possible, and modified as required, both for testing and pilot operations.

But interference measurements can begin without the satellite. Mobile vans and aircrafts can be equipped to make measurements around existing terrestrial facilities. A transportable prototype earth terminal can be sited near such facilities. Satellite operations can then be simulated and measured under a wide variety of climatological conditions, and with varying levels of power and techniques for modulation and energy dispersal. Measurements should be made not only of field strengths but also of the subjective effects of interference.

* Another alternative might be to modify the existing ATS prototype spacecraft which might further the test program at a lower cost.

If interference measurement and pilot operations cannot ride "piggy back" on an existing program then it may be necessary to undertake the design of a new satellite. Experts consulted by the Foundation recommend a satellite containing 6-8 repeaters each capable of relaying one broadcast quality television channel. Two satellites would be constructed, the second to be launched when use of the first justifies additional capability. If only one satellite functions successfully, it alone would be adequate to complete the necessary testing and to provide a useful degree of networking experience. The signals would be transmitted in two beams, one to the eastern half of the continental United States, and the other to the western half.

Whether the piggy back approach is used or a new satellite design proves necessary, the following ground equipment would be useful for conducting pilot operations:

- 2 network terminals with transmitting and receiving capability
- 6 affiliate terminals with transmitting and receiving capability
- 2 mobile terminals with transmitting capability
- 18 mobile terminals with receiving capability
- 20 remote schoolhouse terminals with receiving capability

This ground equipment can be used later for an operational satellite system and thus should not be regarded as a cost of the test program.

The first three types of terminals would be primarily used by the commercial and non-commercial television networks in the production and distribution of programs, and in testing various network configurations. One of the network or affiliate terminals would be used on a time-shared basis to originate instructional programs. The 18 mobile receiving terminals would be used for instructional television purposes to demonstrate satellite program distribution to non-commercial stations and to classrooms for instructional use. The 20 schoolhouse terminals would be so placed as to evaluate a wide-area operational direct-to-school transmission system.

The network terminals would be located at New York and Los Angeles. The affiliate terminals would be used by the networks to feed established regional microwave networks and to permit insertion of regional commercials. Each terminal would simultaneously serve all networks, including non-commercial stations.

The two mobile transmitting terminals would be used by the networks at points of remote program origination, relaying these programs via the satellite.

As suggested by Hammett and Edison, an instructional television demonstration and evaluation program would occupy one or two satellite channels and would require the 18 mobile receiving terminals and the 20 schoolhouse terminals. Each mobile terminal would be a complete, self-sufficient television demonstration system consisting of an antenna, a

dual-channel receiver, a video distribution system, and approximately 50 color television monitors to be placed in classrooms and auditoriums. Traveling with the terminals would be an operations team consisting of two technicians to install, operate, and maintain the equipment and several trained demonstrators to work with teachers and administrators.

All 20 schoolhouse terminals would be placed at schools in a single geographical region. They would remain there for periods of a year or more, in order to integrate the programs they provide into the school curricula. Access to the available channel or channels could be time shared between state educational entities transmitting programs only to schools in their respective states and a regional body organized to test the feasibility of cooperation on a wider scale.

Directly, or through a corporation formed for the purpose, the Foundation would be prepared, if a test program is undertaken, to consider how it may contribute toward:

Training personnel in non-commercial networking operations through the satellite

Training teachers and educational administrators in the more effective use of instructional television

Making available programs for both non-commercial and instructional television

PART 5

NON-COMMERCIAL AND INSTRUCTIONAL TELEVISION: PROMISE AND OPPORTUNITY

Section a. Instructional Television by Wilbur Schramm*

We have now had a little more than ten years of experience with instructional television.

Already it is in use in 50 countries. Here in the United States about 10 million elementary and secondary students and 600,000 college and university students now receive a part of their curriculum by television. Hundreds of controlled experiments on television teaching have already been done.

Ten years is a short time in the life of educational technology. It took 350 years after Gutenberg before we found out how to make and distribute textbooks to meet the special needs of schools and colleges.

Today, two factors dictate a new look at the opportunities and problems of instructional television:

-
- Wilbur Schramm holds the Janet M. Peck Professorship of International Communications at Stanford University, and is Director of the Institute for Communications Research at Stanford. Dr. Schramm was Dean of the Division of Communications and Director of the Institute of Communications Research (which he founded) at the University of Illinois. He is the author of several books on communications and television, including "Television in the Lives of Our Children," published in 1961. He also is a consultant to the International Institute for Educational Planning, established by UNESCO, and recently completed 23 case studies in 18 countries in the uses of new media in instruction, including television.

First: the educational system as a whole is experiencing vastly increased demands and these are bound to get higher in the years ahead.

More and more pupils will be in school, and for longer periods. For many adults, continuing education and refresher training will be a pattern of life. There will be more to teach and learn. In ten years our scientific knowledge will double. All this will strain our educational resources to the utmost -- teachers, schools, teaching materials, financial support.

Second: there is the prospect of a new television technology -- the satellite. Can TV in this new form help us meet the monumental educational tasks ahead?

This paper will first review briefly the record of instructional television to date -- its accomplishments as well as its failures. Then we will take a closer look at some of the demands facing the United States educational system over the coming decades to see what impact instructional television might have on them. Finally, we shall ask what the satellite adds to all of this.

Instructional Television - The Record and the Promise

Since 1956, Hagerstown, Maryland, has taught the core of its curriculum by television throughout all twelve grades to every student in the county school system. Results were so good that the school board, after observing the program for five years, looking at the students' achievement scores, and collecting anonymous opinions from teachers and administrators in the system, voted unhesitatingly to take over the \$600,000 annual cost and continue the program.

By using television, they have been able to offer science from the first grade to the twelfth, music and art in all schools, modern language courses as far down as the third grade, and such specialized courses as calculus in high school. None of these activities was possible before television made it possible to share expert teaching. Before instructional television, two-thirds of American junior high school students rated above the Hagerstown average in standardized tests of mathematics; after four years of televised instruction, two-thirds of American students rated below them -- the Hagerstown average rose from the 33rd to the 68th percentile (measured against national norms) on problem solving; from the 31st to the 84th percentile on arithmetical concepts. Eighth grade students in general science scored two full grades higher on national norms, after three years of television than students in the same grade had scored before television. In one measurement, low-ability children were found to be progressing about twice as fast under televised teaching as comparable students under conventional teaching.

In a quite different kind of project, the Chicago school system has for ten years offered a complete junior college curriculum by television. Requirements, subject matter, examinations are the same in every way as for students on campus. Home students have certain hours in which they can consult instructors if necessary by phone; they send in some written work to be corrected and come to campus for a few special classes and for examinations.

Every year about 10,000 students register for courses, and 10,000 to 40,000 unregistered viewers are in the audience for every broadcast course. Consistently, home students have done as well or better than students on campus in the same courses.

There is also the Midwest Program for Airborne Television Instruction (MPATI) which broadcasts instructional television programs from high flying aircraft to schools in a six-state region. Perhaps the greatest contribution of MPATI to instructional television has been a technical one; namely, it has demonstrated that airborne broadcasting can be effective over a 400-mile circle. In addition, the program has demonstrated that schools and school systems throughout this region can cooperate on program development and the sharing of instructional television broadcasts.

One of the most spectacular uses of instructional television has been under way since 1964 in American Samoa, in an effort to raise the level of instruction in the schools from traditional rote learning to modern education in a few years rather than the century or more it might take if events were left to follow their natural course. The United States government has consolidated the schools, installed six channels of open-circuit television, and provided expert help. The curriculum is being taught by teams consisting of expert studio teachers in each subject matter field, other teachers who prepare exercise and reading materials, and the native classroom teachers who are helped by supervisors and workshops to manage the learning activities in the classroom.

There is little hard evidence on the experiment as yet, but observers report unanimously that remarkable progress is being made in language learning, in particular, that questions, experiments, and individual inquiry are beginning to replace rote drill, and that the native teachers are indeed practicing new methods. When one observes a Samoan teacher who, two years before, would have been content to have her class repeat a lesson after her -- when one observes such a teacher studying a lizard with her class, asking what the animal eats and who eats it, and working around to a discussion of the balance of nature, then one can hardly doubt that profound changes are coming to Samoan schools. Indeed, observers have asked whether we do not have deprived schools on the mainland which might benefit from the same learning opportunities as are being offered in Samoa.

In a number of American schools television has made it possible to introduce modern foreign language courses in the elementary school, although most elementary teachers are not well-prepared to teach the language. Denver, for example, has done this; the results have been carefully studied, and the method widely adopted.

In many medical schools instructional television has made it possible for a large number of students simultaneously to watch surgery from a vantage point or observe a microscopic examination. In some colleges and universities television is used extensively. Penn State, for example, offers

twenty-eight courses, from family economics to meteorology, by television, and tapes them for use on other campuses.

Thus, instructional television can be exciting and effective.

Yet for all these success stories, ITV has been, in many ways, a disappointment. Measured against the great problems of education, its uses have so far tended to be rather insignificant. It has been used most often by the schools that need it least -- the innovative schools that already have an outstanding corps of teachers and are abreast of new developments in method and matter. Despite generally encouraging research results -- ITV usually does at least as well as ordinary classroom teaching* -- there have been more cases than we might expect when instructional television has not made the hoped-for impact in actual use.

* A summary of 390 comparisons of televised teaching with ordinary classroom teaching in American schools found that in 63 percent of the cases there was no significant difference, in 21 percent of the cases pupils learned significantly more from television, and in 14 percent, significantly less. A rigorous study examined existing comparisons very closely and focussed on a small number in which all the possibly contaminating variables had been controlled so that the comparison clearly measured the effect of doing the same teaching by television vs. the effect of doing it face-to-face. In no case was a significant difference found. Nor is it easy to see why there should be a difference, inasmuch as television is only a device to carry teaching and demonstrations. Its advantage is to be able to draw on a larger supply of excellent teaching and demonstrations and make them available where otherwise they might not be seen -- not necessarily to be able to present them any better.

For example, Continental Classroom began with considerable enthusiasm, offering a course in atomic-age physics broadcast at 6:30 A. M. over more than 150 NBC outlets. The special hook-up was designed to make the course available to any college in the United States; 300 of them picked it up the first year. Courses in chemistry, mathematics, and American government followed. After several heavily subsidized seasons and impressive records of participating institutions and viewers, however, Continental Classroom was dropped. Broadcasting instructional programs using commercial stations runs smack into strong competition from commercial programs. For this and other reasons, Continental Classroom has all but passed from the scene.

Another project that began with high hopes of ameliorating a severe shortage of teachers in Texas lasted about as long as Continental Classroom. Between 1956 and 1959, every teacher training institution in the state, the Texas Education Agency, and 18 commercial television stations cooperated in a program of teacher training, and enrolled more than 1,000 college graduates. Any recruit who enrolled for credit qualified for a temporary teaching permit after successfully completing the one-year televised course. But the statewide experiment found no followers in other states, and Texas itself dropped the program when its foundation grant ended. Actual results were disappointing: the pool of recruits was smaller than expected and the per capita cost of training was high.

More generally, now that we have moved beyond the first burst of enthusiasm, we know that there is no magic about instructional television. Dull teaching on a picture tube is no better than dull teaching in a classroom. Outmoded methods of teaching language or art or science or mathematics are no better on television than elsewhere. They may be worse, because more is expected of them and so many people can observe them. Television is only a pipeline. It is likely to be as interesting as what goes into it, and as effective as the learning activity that can be generated around it.

From this mixed and spotty record, what can we say about the conditions necessary for ITV to fulfill its promise -- to be truly effective. Two of these conditions can be stated with some confidence:

We must have truly excellent programming adapted to the special needs and resources of television as a teaching medium. And, second, we cannot rely on television to do the job alone. It works best with informed and active participation of the classroom teacher at all stages of the process of learning.

Let us examine each of these in some detail.

Programming

U. S. Commissioner of Education Harold Howe has remarked wryly that "like the drug for which there is as yet no disease, we now have some machines which can talk but as yet have nothing to say." Instructional

television has typically been in the charge of broadcasters who were not experienced educators, or educators who did not know broadcasting well. Often it does the most obvious thing -- film what happens in the classroom, the panel discussion, the chalkboard as a visual aid, the "lecturing face as a focus of attention." As Rudolph Flothow of Lockheed has pointed out, television has typically put the teacher in his least effective role -- as dispenser of information.

But television has a great power to challenge a student:

- by showing him a problem vividly and letting him try to solve it;
- by letting him follow through a scientific experiment, deciding at each point what should be done next, and checking his procedures against those of the experimenter and his predictions against what actually happens;
- by playing a game with him, using either the quiz pattern so popular on commercial television, or more sophisticated games such as those by which Nobel laureate William Shockley lets grade school children learn how to solve problems.

Television should keep the student active, not passive before the tube. It should invite discovery on his part, rather than foreclosing discovery by giving all the answers. To do this, it has to be willing to stop talking and let the viewer take part; it has to stop telling him and listen to him; stop trying to fill his mind, and let him exercise his mind.

Most of the weaknesses in its programming, says Jerome Bruner, "exist because we have neglected the potential and failed to exploit it to the fullest For the future of instruction by television, the greatest mistake could be to put it to work sanctifying the traditional. Simply filming lectures, panels or seminars ties television to all the blarney of the old academic techniques. [Instruction by television] needs invention. Felicitously discovered, television can then serve as the quality control for the entire educational system, building and maintaining taste to a level never before imagined."

Why has instructional television never reached the level of programming excellence it should someday be capable of reaching? For one thing, it is young. We have already mentioned the lack of people with the combination of educational and broadcasting skills.

Furthermore, truly excellent television programming is expensive -- ordinarily more costly than most school systems can afford alone. It requires a wide base in teaching resources. In conventional instruction, the resources base is the school itself -- its libraries, laboratories, instructional aids, the total capabilities of its teachers and its facilities. In practice it is often smaller than that, restricted essentially to the teacher and his classroom. From this base the teacher draws his information, illustrations, examples, practice patterns.

Potentially, instructional television can draw upon a larger resource base. Large stores of information become available. The capabilities of a

number of individuals can be drawn upon in the preparation of the teaching, and the presentation itself can be planned and rehearsed, step by step, before it is actually made. But if the base is to be larger, it takes more money for programming to draw all these resources together for a vivid and meaningful impact. In actuality, however, ITV has too often been restricted to the same narrow base as conventional instruction and financed at bargain basement prices.

The Classroom Teacher

Only in the rarest of situations can ITV be counted upon to do the whole job of teaching. It can carry lectures and demonstrations, but it is not a very flexible tool for directing practice. And it cannot conduct a good class discussion or talk over a pupil's own problems with him.

In some cases, where students are homebound or where television is used alone for experimental purposes, they learn a great deal from television. But they learn a great deal more if classroom activity is integrated with it.

In fact, almost nowhere in the world is television being used alone to carry a serious responsibility in instruction. The pattern of use that is emerging is a kind of team teaching, in which one teacher does his part of the teaching in the studio, making use of all available teaching resources, including subject matter specialists and production technicians, and of extra time to build substance and illustration into an effective presentation of 10 to 30 minutes. Then other teachers carry out their part of the teaching in the

classrooms, weaving the television into the pattern of classroom activity, handling discussion and questions, encouraging individual inquiry, and centering their efforts on the individual student's learning activities.

Thus, ITV does not displace the classroom teacher. It gives him a new and potentially more rewarding role. He must plan together with the studio teacher, coordinating the work. He is still responsible for instruction, but he can draw on new resources. He must prepare the class for instruction, supervise its activities, reinforce the responses to be learned, and evaluate the results. If well done, the product is an efficient teaching-learning system -- studio teacher, classroom teacher, teaching materials, guidance activities. In this system, the classroom teacher remains the fulcrum. It is not surprising that ITV meets a certain resistance where this central role for the classroom teacher has not been made clear in advance or achieved in practice.

Where instructional television has been used most effectively, it has been used this way as an integral part of a teaching-learning system. The participants in that system share the planning and the decision-making, and find their new roles neither threatening nor degrading, but rather potentially highly rewarding. The studio teacher, after his first anxiety at having his teaching exposed to the critical eyes of his colleagues and superiors, has been grateful for the added time and help in preparing his lessons. The classroom teacher has found that, freed of some of the responsibility for "telling" his students, he can spend more time teaching them, more time encouraging their individual

learning activities. The principal finds that he has an opportunity, if he wishes, to spend less time on curriculum and scheduling, and more working with his teachers. All are likely to gain a new vision of what cooperative teaching can accomplish, and the level at which a classroom can operate given a sufficient resource base. Every competent study of teacher and school administrator attitudes toward television used in this way has found that these attitudes became more favorable as people gained more experience with the new method.

These two conditions -- adequate programming and effective participation -- have rarely been met together. Thus, in a sense, instructional television has not yet had a real test in this country. It has not had a sufficient resource base or been used in the way it works best.

Even more significant, we have not used it in the schools that most needed it or applied it to the great problems where there is a "felt need" for it.

What instructional television has been is not the measure of what it can be.

The Need

It is no accident that the more spectacular uses of instructional television tend to occur in the developing countries, where educational needs are so glaring that extraordinary means and nontraditional methods are clearly required to meet them. In the entire country of Niger there are only 66 qualified teachers, and slight chance to add to this number because the tiny trickle of educated young people has to be piped into other parts of the

development program. In that situation the potential usefulness of television to share such expert teaching as there is, could hardly be questioned.

By contrast, we have felt less need for the new weapon and have not taken it very seriously.

But we do have educational problems of a size and importance to challenge instructional television to its full potential. Conversely, the widest application of ITV, at least for the foreseeable future, is not as a scattershot seasoning throughout the educational system but precisely in bringing massive resources to bear on these insistent problems. What are some of them?

The Deprived Schools

These schools are with us now. Some of them are Negro schools where we are beginning to try to make up for decades of shameful neglect. But there are others, equally laggard. Some of them are in remote areas. Others rest on an inadequate financial base. Whatever the reason, in many of them a majority of the pupils have already fallen so far behind by as early as the fourth grade that the door to educational advancement is already closed.

What is the high school situation? Here are figures for one state whose situation is not at all unique. Forty-one percent of the pupils in grades 9 to 12 have no opportunity to study a foreign language; 84 percent have no opportunity to study art; 47 percent have no opportunity to study

agriculture; 60 percent, no opportunity to take courses in industrial arts; 72 percent, no opportunity to take courses in preparation for trade or industry.

Suppose, now, that this state and others like it were able to deliver a full quota of students to high school. The high schools would have to increase their course offerings enormously to produce confident and useful citizens, able to go to work after high school or go on to college. But more than one-sixth of all the high school teachers in charge of science, mathematics, and foreign languages in this one state do not have their certificates endorsed for those subjects. That means they have had no special training in those fields. And the need for solid training in subjects like these is extended farther and farther down into elementary school; a higher and higher proportion of teachers will have to teach these basic courses without special training in them.

There is no royal road to improving the lagging schools. There is no way to do it without money and personnel. No one wants to accept a situation in which these schools have a lower proportion of highly trained teachers. But we must speed up the process of improvement by sharing the teaching resources we have.

The resemblance to the Samoan situation is obvious. In that case the United States government admitted that it had neglected the development of schools. The plan for rectifying the situation as quickly as possible was

to spread the benefits of high quality teaching and well-planned and well-supported lessons. And as we have seen, the plan was no threat to the existing classroom teachers. Indeed they were vital to its success. And their own professional performance improved as a result.

The essence of the Samoan plan is not television; it is sharing resources. Television was simply the most efficient way to do it.

We can hardly ignore the implication. Can we afford to be less imaginative and less resourceful on our mainland than we have been in the Pacific?

A New Standard of Quality

Of one thing we can be absolutely confident as we look ahead: American education will not be content to stand still. It will demand higher quality of product.

Can instructional television contribute to this? If it cannot, if it is quantitatively but not qualitatively useful, then we are much less interested in it.

Before we can expect a real contribution to quality from television, of course, we must learn to use it well. This means learning to use it as a teaching-learning medium, rather than an informing or entertaining medium; learning how to integrate it into the existing educational system in such a way as to make full use of the present corps of teachers and administrators and to get it used efficiently in the classroom. It also means that there must be enough money to program it adequately. If those requirements can be met, then the possibilities are quite exciting.

How many nuggets of excellence have we in our schools that would contribute to the general enrichment if we could share them? A great teacher here. An exciting demonstration there. A challenging lecture or series of lectures in one place. A drama in another. How many truly excellent learning experiences like these might we share widely instead of restricting them to a single audience or a single class?

Think what television might mean to teachers themselves. At present the lag between our educational innovation and its widespread application in the classroom is at least five years. This is what it takes to work down through the process of publication, consultation, workshops, and special training. To reach all schools may take as long as 50 years.

But suppose that the innovators and expert consultants could be made available on television, rather than in person. Suppose that the workshops could be held on television, rather than in person. Suppose that advanced courses for teachers could be made available by television so that teachers could maintain an ongoing program of advanced study and professional improvement, with appropriate rewards, rather than waiting for a free year to go back to a university. Would this not reduce the lag in adoption of new methods?

Impressive evidence comes from many parts of the world that the experience of seeing excellent teaching on television is itself an effective way of improving teaching in a classroom. Many who, in the last few years,

have seen a truly excellent teacher like David Page, teaching the new math by means of a dialogue with elementary school students -- drawing them out, leading them to discover for themselves the relationships and processes they should know -- have realized for the first time what this kind of teaching might be and do. And all have known that our own teaching would never be quite the same again.

Instructional television can enrich the learning of its users by gathering up experiences that would enlarge their environments. It could bring agricultural life to city children; city life to rural and small town children; an intimate sense of government, of science and industry, of other countries; some acquaintance with great men, great art, great events.

The real challenge of this new technology to us is that we should use it to share this kind of experience and excitement, this kind of quality, with all the schoolrooms of America that want it.

Expanding Schools

The United States Office of Education estimates that by 1970 approximately 60 million young people will be enrolled in our schools: 37 to 38 million in higher education.

By the early 1970's there will probably be a powerful movement toward providing school for everyone from about age 3 to about age 20. There is more to be learned, and more special skills needed for employment. Children must be brought earlier into a group that will motivate them. We will want

to bridge the awkward period when teen-agers who are not specially trained have a hard time finding jobs. If we do indeed adopt a general pattern of schooling for everyone from 3 to 20, it will have the effect of doubling school population.

We can look forward to all-year schooling, a longer school day, and training for more and more specialized jobs.

Not only will the amount of knowledge to be taught this greatly enlarged school population be much greater, but also there will be new ways of teaching it. And new approaches to knowledge will interact with new methods as they already have in the "new math" and the new natural science curricula. Information retrieval centers, increased use of computer-based instruction, and the new curricula jointly planned by subject matter and experts in teaching are signs of what we may expect. Undoubtedly, therefore, there will be a broad need for retraining teachers and keeping them up-to-date in subject matter and method.

There is no reason to think that we cannot solve this problem. We faced something like it once before in the 1920's and 1930's, when the schools were asked to meet the new and higher intellectual goals then set by educational philosophers and leaders, and also to take care of the children who became available when child labor was closed off, and when the Depression forced us to create work, reduce unemployment, and hold educable youngsters in school. We met that problem, made long strides toward universal primary education,

and were able to report that for the first time in history a major nation had more than 50 percent of the relevant age group in secondary school.

That achievement brought the nation rich rewards, but it was not accomplished without extraordinary efforts and without raising some extraordinary problems. We cannot expect to meet the educational demands of the 1970's and beyond without comparable problems and even greater efforts.

Here too the requirement is for the best and most effective technology we have available.

Lifelong Education

Educational needs of the future will not cease with age 20. Continuing and refresher education is likely to become a way of life for American adults. "In this age of sweeping scientific discovery and rapid technological change, highly talented manpower must undergo continuous self-renewal if it is to maintain its creative potential," said the National Committee on Utilization of Scientific and Engineering Manpower, in 1964. For all workers, the committee said, "obsolescence is an occupational hazard against which the individual must guard." A straw in the wind is the practice recently instituted by the French Atomic Energy Establishment at Saclay: their diploma lapses after five years unless revalidated by attendance at refresher courses and success in further examinations.

In the coming decades, professionals will need constant updating. Already the University of California has on its rolls one out of every three

lawyers and one out of every six physicians licensed in the State, for refresher courses.

There will be an immense need for job retraining with changes in technology and the coming of automation. Some idea of the dimensions of this field may be gathered from the fact that in 1963 there were enrolled in federally aided vocational programs 828,000 in agriculture, 1 million in trades and industry courses, 1,800,000 in home economics, 54,000 in practical nursing, and 185,000 in skilled technician training.

There will be a great need for teaching in-service training.

And beyond all these will be the need for more general education of adults. One interesting new dimension will be education for the aging. As early as 1957, U.S. Office of Education statistics showed that more than one-fourth of all people enrolled in formal programs were over 45. And the demands of useful and informed citizenship in the changing world we live in will undoubtedly lead more and more people into general adult classes.

There is no bomb shelter against the learning explosion.

Whatever happens, we know we shall have to have more teachers, more materials, larger libraries, and more schools. But if we are to have a chance of meeting the needs sketched above, we must share effectively the resources that we have. This is where instructional television comes in.

As we have seen, it is essentially an efficient method of gathering in teaching resources from a wide base and sharing them broadly among large numbers of users.

From many countries now we have precedents to indicate that if good teaching and demonstrations can be brought in by television, fewer highly trained teachers will be required in residence, and some of the work can be supervised by monitors and chairmen, rather than subject matter experts. The experience of these countries indicates that well-designed television can be a powerful aid and support, rather than a threat or annoyance, to classroom teachers, a way of liberating them from some of the demands upon them and freeing time for other essentials of good teaching.

Furthermore, we have evidence from our country and elsewhere that home teaching or out-of-school group teaching can be done efficiently by television. Several dozen countries now teach by television everything from literacy to surgery refresher courses in this way. Japan, the Soviet Union, and other countries now offer secondary and college-level courses by television combined with correspondence study. Industries, here and elsewhere, have found that their employees could learn needed skills effectively through television, film and programmed learning. This experience cannot be disregarded when we face the kind of demands for persons and facilities that we do now and shall increasingly face in the next years.

The Implications of the Satellite

How much excellent teaching could we share more widely by television?
How much learning could we center outside the schools by combining television

with correspondence study or out-of-school group study? How much could we strengthen the learning resources available to our students? The answers we make to these questions are inevitably related to the uses we are able to make of instructional television. Increasingly they are becoming related to the use we might be able to make of a satellite for education.

Nobody knows exactly what the effect of a satellite for education would be, for there has never been one. We can say with some confidence what it would not be, however. It would not be to create a nationally controlled system of education or a government office to program the satellite. Unlike many other countries, we rejected that possibility a long time ago. We have de-centralized control over our schools.

Whatever television reaches the classroom through a satellite will come in, like all other learning experiences in the school, because the school boards, trustees, administrators, and teachers say it should come in.

This does not mean that every school would itself program the satellite. No medium with a coverage area as large as a communication satellite can be programmed efficiently on a school-by-school basis. But the alternative need not and should not be a single national program center. It is possible that there would be enough channels to assign one to a state, so that the schools and colleges

of the state might cooperatively decide how to use it. Or a channel might be programmed by a regional organization to meet the special needs of that region. Undoubtedly, many programs would originate in individual schools. It is possible to conceive of a national educational program office to cover public events of great educational importance, or to handle production on order from state or regional organizations. There would almost certainly be need for a national program library, to facilitate exchange of programs and materials. There will be numerous and diverse program sources. But control will throughout the country remain where it is now -- with the educational system.

The main difference between instructional television by satellite and instructional television without it is that the satellite will offer a much larger base for sharing resources, and a much quicker way of doing so. A new course, developed and produced by one of the national professional organizations -- or by a university or school system -- might be offered to all the nation's schools at once, if there were sufficient demand for it, rather than filtering slowly down through all the separate educational television outlets and individual school systems. This might have been done, for example, with the Physical Science Study Committee's new course, or the "new math" when it was new. It could still be done with the new biology or the social studies course which is in preparation.

The wider the use of a course, the greater the resources that can be put behind it, and therefore the more likely we are to have distinguished programming.

A single school system has difficulty in finding the money to produce instructional television of consistently high quality. If it does produce excellent material, it seems wasteful not to share it with other systems. If the process of sharing can be enlarged -- with neighboring school systems, with the schools of a state or a region, with schools or colleges of similar kinds throughout the country -- then it is possible to draw on greater resources and more skilled professionals to produce the material. The result is likely to be higher quality.

It is easy to exaggerate the importance of timeliness in instructional television. Only a portion of educational transmission would need to be handled in "real time." Yet the advantage of being able to be timely when necessary, and to share materials quickly, is a great one. Suppose a class in Arkansas, as well as a home audience, could have a seat at a Congressional hearing or a UN debate or a press conference. Suppose it could join young people its own age in a walk through the White House, or Harlem, or the New York Stock Exchange, or the Mt. Palomar Observatory, or the TVA power works. Some of these would gain more than others from timeliness, but there is no doubt that satellite-borne television could bring distant environment to classrooms with a contemporaneity and realism that is not possible in any other way.

For higher education, we can envision lecture or interview series with great scholars of the world, with chiefs of state, with heads of national and state government agencies or Congressional Committees. Universities

could share lecturers, campus to campus, or join together in seminars with two-way questions and discussion.

A communication satellite could provide voice links from some of the participating classrooms back to the teacher, for questions and discussion with the television teacher. In the same way circuits could be maintained back to the studio, or to some other central places where the responses of pupils to questions or to opinion items might be recorded. This could be handled in such a simple way as the pupils pushing buttons numbered according to answers or opinions. Both the teacher and the student would know what answers are being given, and, if there is a right answer, whether the student has given it.

The satellite could be a channel for the rapid exchange of data between scholars or libraries. The scholars of this country, suffering with problems of information storage and retrieval, delays in getting articles published in journals and difficulty in keeping up with the new knowledge from other laboratories, could conceivably by means of the new channels, be able to call upon a distant colleague for information, or order information from a library or data bank.

Conclusion

Here is the challenge:

-- to apply the developing technology of instructional television imaginatively to the great problems of American education

- to use it to share our resources of excellence as widely as possible
- to do so in a way that supports and assists the classroom teacher
- to offer through it new and more challenging learning opportunities to students
- and to humanize rather than mechanize the educational process

As Charles Frankel has said, we must work within and we must solve, "the overhanging problem of using technological progress to enhance rather than destroy humane values and the aesthetic quality of life."

Instructional television and the communication satellite are not the whole answer to this challenge. But we cannot afford to overlook the contribution they could make.

Section b. Non-Commercial Television

"I believe television is going to be the test of the modern world, and that in this new opportunity to see beyond the range of our vision we shall discover either a new and unbearable disturbance of the general peace or a saving radiance in the sky. We shall stand or fall by television -- of that I am quite sure." E. B. White, 1938

Television cannot become a "saving radiance in the sky" -- the phrase was coined when television was still in the laboratory -- if it must depend exclusively on the programs of the commercial networks and television stations. This is not because the commercial networks cannot be excellent, they often are, but because excellence cannot be their goal all of the time or even a large part of the time.

The best of the commercial television programs are creative, vital, and imaginative. In some areas -- spot news coverage, light entertainment, spectacles -- non-commercial television would have a hard time matching the quality of existing programs. Moreover, the commercial networks now carry many of the programs that a non-commercial network will feature: drama, discussion, news analysis, ballet, documentaries, and public affairs. But programs of this kind are the exceptions for commercial networks, not their staple diet. The president of the Taft Broadcasting Company, Lawrence H. Rogers II, explained why in a speech last May "~~P~~roviding for the cultural uplift and in-depth education of the American people is not properly the principal function of mass communications ... much less the sophisticated

mass communication represented by American commercial television. It could not accomplish this goal even if it would. For as soon as the medium aspires to educational and cultural standing it automatically loses its reason for existence: namely, its mass audience. Once it has lost its mass audience, it has lost its attraction for the more than two billion dollars annually that advertisers pour into the apparently insatiable program digestive system.

"A national cultural and educational TV system cannot be wholly provided by a free commercial mass medium; it's as simple as that."

The inexorable law of commercial television is that big audiences drive out smaller ones. It may be, as some critics suggest, that advertisers and network executives pay too much attention to ratings, but this criticism goes more to the validity of particular methods of rating than to the underlying reality: by the best tests they can find, both advertisers and networks are bound by their profit motives to seek the largest possible audiences. Their time for other things is small. Commercial television is commerce first -- and with marginal exception it exploits only that part of the promise of television which gives the most assurance of the most profit. To the commercial networks, time is money, and they cannot give much of it away.

It follows that non-commercial television must do the job that commercial television cannot do. It must "aspire to cultural and educational standing." Walter Lippmann stated the justification for non-commercial educational television in 1959 when he wrote that it should be a "network which can be run as a

public service, and its criterion not what will be most popular, but what is good."

"There are a lot of other things that need to be done besides producing and selling goods. One of them is to inform, instruct, and entertain the people through the media of mass communication. And among these media there must be some which aim not at prosperity and profit, but at excellence and the good life." *

If what is lacking in commercial television is time, what is lacking in non-commercial television is money.

What educational stations cannot afford to do separately, they cannot afford -- yet -- to do together. Commercial television is made up of strong stations and strong networks, interacting on each other in the market place. The stations have time and audiences; the networks have national advertisers and pools of national talent; both have wealth. Educational television, by contrast, has little money and no network at all. The nearest thing to it is the National Educational Television and Radio Center, with a budget of about \$8 million a year (\$6 million of which comes from the Ford Foundation alone). It can manage only five hours of new programming each week, and at that its average program budget is only a fraction of the figure for commercial television.

* Walter Lippmann, "The TV Problem", New York Herald Tribune, October 27, 1959

As a group, non-commercial stations are the victims of a cost-quantity-quality conflict in providing a program service for their viewers. Unlike commercial stations, they cannot depend upon a strong network to supply the bulk of their programs. The few hours of national program service (through NET) are distributed by mail because there are not network facilities for the non-commercial stations. Thus, they are forced to do an unusually heavy portion of programming themselves. Yet, almost without exception, the non-commercial stations must operate on marginal and inadequate budgets. Program costs must be kept low. One commercial network "spectacular" usually costs more than the entire annual operating budget of the average non-commercial television station.

As a result, local non-commercial programming is highly uneven in quality. There have been occasional flashes of brilliance and real imagination. Some of the better non-commercial stations have set high standards for effective, hard-hitting analyses of important and controversial local issues. KQED's "Profile Bay Area" and KETC's "Metropolplex Discussions" come to mind. Some stars developed by non-commercial television have gone on to commercial television stations and networks. Some of the innovations have found their way into commercial broadcasting. Still, the great bulk of local programming remains mediocre at best and dependent upon conventional format and subject matter.

In our August 1 Submission we attempted a general statement of the limits of things that could be done at a new level of quality by a strong national

non-commercial television service. We here repeat ourselves in part:

Such a non-commercial television system could provide a spectrum of informational, cultural and instructional services as wide and deep as knowledge, wisdom, talent, and imagination permit.

The informational service could include:

- . Full and live coverage of significant hearings and debates.
- . Interpretation of news.
- . Interviews and discussions featuring outstanding leaders in all fields.
- . Documentaries on important international, national, regional, and local problems.
- . Live and filmed reports designed to give the American people a better understanding of the three branches of government at all levels.
- . Broadcasting coverage of national and local political campaigns, including free time, under appropriate safeguards, for candidates for political office.

The cultural service could include:

- . Musical, dramatic, and literary events of high quality from any location in the country.
- . Programs featuring established works and artists as well as important new works and promising young artists.
- . Broadcasts covering the whole range of the humanities.
- . Special events, such as the premieres of important new dramatic, operatic and symphonic works.
- . Program series devoted to the history of the United States and to the history of American institutions: the Presidency, the Supreme Court, the Congress, the public school system, the military establishment, the university.
- . Programs of quality and taste for children.

We know that many of these things are done already, at least in some degree. Commercial and non-commercial television have both had their triumphs. Indeed, our hopes for the future rest in large part on the best of what has been done in the past. The list merely suggests the range available if programs are designed with freedom from present crippling limitations -- time and maximum audience in commercial television, poverty and single-station programming in non-commercial television.

Since August we have talked with artists, newsmen, educators, producers and technical experts. In the light of the responses, we conclude that the best way to make progress in this area, in the immediate future, is to offer new opportunities for programming that may help to demonstrate to all what the experts appear to believe without argument: that effective non-commercial television can add a new dimension to our cultural life. The shape of this new offer is outlined in Section c. on the following page.

Section c. An Appropriation for National Programs

The Trustees of the Ford Foundation recently appropriated \$10 million for new experiments in non-commercial and instructional broadcasts inter-connecting some or all of the existing 125 KTV stations.

The Foundation expects that this appropriation will be used both for programs developed by consultants and experts directly engaged by the Foundation and for programs prepared by others. The Foundation's purpose in either case will be the same: to make possible a widespread demonstration of the power of television set free from the constraints of commerce and of poverty.

The Foundation has a particular interest in demonstrating the special value of a true educational network. The best way of demonstrating this value would be through the use of a properly designed test satellite -- the real thing is much better than its simulation. In Part 4 of this volume we discuss an experimental test satellite program. But we have no test satellite today and it is greatly to the national interest not to lose time.

The Foundation believes that if plans are pressed with energy and confidence, there can be remarkable demonstrations of the power of a national educational television service during the year 1967-1968. We see particular promise in a proposal to pull together the intellectual and cultural resources of this country to speak directly, once a week, to the great issues of the day in every field of action. We are persuaded that if first-rate production can be married to first-rate minds, and focussed on questions that matter, the nation

can be offered enlightened comment at a level never seen before. We are prepared to assist in providing funds for simultaneous network broadcasting of a program of this sort -- and of others that show parallel promise.

We see an equal, but still more difficult opportunity in the field of instruction. On a national scale, we believe instructional television has never truly been tried. Possibilities like those sketched by Dr. Schramm in Section a. above need to be tested in practice. We need to find ways of demonstrating the value of network television for effective formal instruction, while scrupulously respecting the principle of local control of education. The Foundation herewith declares its concern in this field and its readiness to support first-rate experiments that offer a prospect of progress in this direction.

Section 4. The Experience in Other Countries

Our proposals are not patterned on any existing non-commercial service or organization. The communications and broadcasting industries in this country have, in contrast to the experience of many other nations, been owned and operated privately rather than by the government. We are larger and more heterogeneous than most nations. We have our own experience and our own tradition.

The experience of others is offered not as a model but to illustrate the range of possibilities and the varied ways in which common problems have been met.

Non-Commercial Television

Non-commercial television plays a much more important role in other countries, such as Britain, Canada, Germany, Japan, and Sweden, than it does in the United States. In many of these, it has exclusive or at least substantial responsibility for the whole range of entertainment, news, and cultural programs that are produced by the commercial networks in this country.

In most countries, non-commercial television is entrusted to a public corporation or some other public body. The usual model is the British Broadcasting Corporation, which initially had a monopoly. Many advanced countries have built on the experience of the BBC, adapting it to their own needs and requirements.

Five main issues can be identified:

1. The extent of the privileged position granted to the non-commercial entity
2. The form or organization
3. Finances
4. Program standards
5. Political control and accountability

1. Extent of Privileged Position

In France and Sweden, the non-commercial television entity (Office de Radiodiffusion-Télévision Française and the Swedish Broadcasting Corporation) continues to have a monopoly of all television broadcasting. The more general pattern, however, is one of competition, and the trend is in this direction. The BBC now faces the competition of a full-fledged commercial television service. Private commercial broadcasting operates side by side with the Canadian Broadcasting Corporation in Canada and with the Japanese Broadcasting Corporation in Japan.

2. The Form of Organization

The simplest form of organization is to be found in France, where the CRTF is an official agency of the French government, administered by a Director General appointed by the Minister of Information. In most other countries, the organizational form reflects an effort to secure a balanced representation of the interested groups on the governing body of the television enterprise, and at the same time a greater independence from direct political processes.

The BBC is established by Royal Charter. It has nine governors. Three represent specific regions: Scotland, Wales, and Northern Ireland. Governors serve for terms of five years. They are appointed by the government in power as vacancies occur, but they do not resign when the government falls. The chief executive officer is a Director General appointed by the Corporation. The Corporation has taken advantage of express charter authority to appoint a wide range of advisory councils, some geographic, and others concerned with specific subject matters such as education, religion, science, and music programs for immigrants.

The second British television service, the Independent Television Authority (ITA), derives its revenues from the sale of advertising. But it too is a public corporation with functions defined by the Television Act of 1964. The Authority consists of a chairman, a deputy chairman, and eleven members, all appointed by the Postmaster General. ITA builds, owns, and operates transmitters but does not produce programs. These are produced by independent program companies, now fourteen in number, under contract with ITA. The program companies rent time from ITA and pay a levy (about \$60 million in 1964-65) to the government. The companies in turn sell advertising time to the advertisers. ITA exercises general supervision over programs to insure accurate news reports, impartiality, balance subject matter, and good taste. It is also responsible for holding advertisers to the standards of the Television Act in frequency, length, and content.

The structure of the Canadian Broadcasting Corporation closely follows the pattern of the BBC.

In Sweden, the Sveriges Radio is a public corporation with the shares allotted to the press and other commercial and industrial interests, primarily the radio industry. The chairman and half the members of the Board of Directors are appointed by the government; the other half are elected by the annual meeting of the shareholders. The board appoints the Director General who is the chief executive officer. There is, in addition, a group of twenty-four commissioners appointed by the government to insure that the programs conform to the provisions of the basic agreement between the government and the corporation, and to deal with complaints.

The Japanese Broadcasting Corporation is a public service corporation with functions defined by the Broadcast Law. The members of its supreme administrative body, the twelve-man Board of Governors, are appointed for three-year terms by the Prime Minister with the approval of the Diet. The country is divided into eight districts, each represented by a governor. The other four are appointed from the country at large. The President, who is the chief executive officer, is appointed by the Board of Governors. The President names the vice president and from seven to ten managing directors. The Board of Managing Directors is a basic executive organ which deliberates with the President on executive policy matters.

The organization of television broadcasting in Germany is more complicated, primarily because the constitution assigns jurisdiction over broadcasting to the states rather than the Federal government. The first television network to be established in the Federal Republic (ARD) is a mutual network of nine broadcasting corporations, each established by one of the states. The network has no central programming and administrative headquarters. It is run as a federation, a joint effort of nine regional broadcasting corporations each of which contributes a certain portion of the national television program. Day-by-day the network switches from one of these broadcasting organizations to the other; the first hour of the evening may originate from BR in Munich, the second may come from NDR, Hamburg, and the third from SFB, Berlin.

In the early 60's the Second Network (ZDF) was established to provide competition to the ARD. The eleven state governments agreed jointly to license a new public corporation which started operations nationwide in 1963.

The ZDF and the nine constituent members of the ARD are chartered as public non-profit corporations under public law, independent of state and Federal governments and of private interests. The supervising body of each corporation is made up of the representatives of the government involved, political parties, the churches, the unions and other significant economic and social organizations. It appoints the top officials including the Director General who has wide authority over programs and policy.

3. Finance

Three basic forms of financing are employed, either separately or in combination: user tax or licenses; direct public grants; and revenues from commercial advertisements.

The license fee is very popular. In France it amounts to Fr. 100 (about \$20) annually for television sets. In the UK the annual license is £5 (about \$14). In Germany it is DM 5 (\$1.25) per month. Japan and Sweden also use license fees. In Canada a direct government grant of about \$66 million supplies about three-fourths of the CBC's budget; the rest comes from commercial revenues. The German networks also sell some time commercially.

4. Program Standards

From the beginning the BBC has had broad discretion in developing programs and policy. The Corporation adheres to a strict rule of impartiality. It does not express opinions on current affairs or matters of public policy. It is required to broadcast any announcement when requested by a Minister. In practice, this requirement is fulfilled in ordinary news broadcasting. It is also required to broadcast an impartial day by day account, prepared by professional reporters, of the proceedings in Parliament. It observes a general policy of not commenting on matters to be debated in Parliament in the period immediately preceding the debate. Subject to these limitations, the Director General and the Board of Governors have complete freedom.

In Sweden, although the corporation has full policy and program authority, it exercises its functions under an agreement with the Government. The agreement is general in terms and specifies that programming will have due regard for the central place of radio and television in the cultural and social life of Sweden. Programs are to be varied in nature and content; they must be objective, impartial, and informative; they are to cater to the range of religious belief and of tastes in music, theater, art, and science. The corporation also assumes a duty to stimulate debate on cultural and social questions.

Japan has attempted to control program content by much more detailed written specifications. They contain elaborate provisions concerning broadcasting treatment of subjects such as human rights race, international relations, religion, community life, home, crime, and many others. Canons of expression provide for use of the "standard dialect" in general, for avoidance of "coarse language," "indecent words and actions," "expressions that tend to arouse fear, uneasiness or unpleasantness," "detailed descriptions of physical torture" and the like. There are, in addition, specific standards for various kinds of programs: cultural, educational, childrens', news, sports and others.

5. Political Control and Accountability

Maintaining political independence has been a matter of continuing concern and attention. In Great Britain, the BBC is subject to questions on its policies and activities in Parliament. The questions are answered by the Postmaster General, but the answers are based on information supplied by

the Corporation. There is also a formal authority in the Postmaster General to prohibit by notice in writing the broadcasting of any program. In practice, this veto power is almost never employed.

The independence of the Swedish Broadcasting Corporation is even more striking. The Corporation is not even under an obligation to give the government broadcasting time, except for important public announcements. Political programs in general elections are arranged between the Corporation and the parties. In Germany, the Directors General of the broadcasting corporations, once appointed, are said to have almost complete legal independence in the programming field during their terms of office.

On the other hand, where television broadcasting is conducted as a direct function of the government, as in France, it appears to be heavily influenced by the government in power. In Italy also, although television broadcasting is conducted by a private corporation in which a majority of shares are government owned, it is said that the broadcasting activities are extremely sensitive to pressure from both government and the Vatican.

Conclusion

This survey of non-commercial television shows a varied picture. A broad range of organizational forms has been used. Financial resources have been provided in several ways. Technical standards are high. Programs cover a wide range of entertainment, cultural, educational and news subjects. The problem of independence from political control has, in many cases, been satisfactorily controlled.

In sum, the experience of other countries suggests that the problems of non-commercial television can be resolved, and provides a storehouse from which we can draw as we choose.

Instructional Television

Instructional television is being used in roughly 50 nations and as a major resource in many of these, including Japan, Niger, Nigeria, the Ivory Coast, Italy, Colombia, and Peru. Experience varies from country to country, but the most extensive use of instructional television is generally found in less developed school systems where television is used to offer the instruction that schools cannot provide, particularly in the elementary grades. The medium tends to play a more peripheral role in relation to developed school systems, although there are notable exceptions, with a shift toward adult education and forms of training required to meet designated manpower needs.

Similarly, in less advanced school systems, instructional television predominates over general non-commercial programs; in countries with developed school systems, cultural and information programs receive greater emphasis

The state of development of the school system is only one variable in determining the application and importance of instructional television. The size and organization of the communication system is an important factor, but seldom controlling. Other important variables include the wealth of a nation,

the underlying purpose of its education, and the distribution of its pupils and teachers.

We discuss below applications of instructional television drawn from:

1. Nations with underdeveloped educational systems
2. Nations with partially developed educational systems
3. Nations with developed educational systems

1. Nations With Underdeveloped Educational Systems

In the countries with the weakest school systems, there is no provision for general primary education. Opportunity beyond elementary school is limited to a restricted secondary school for children of senior government officials. There are only a few rudimentary vocational programs -- as for mail clerks, railway employees, and communication personnel -- run by the government agencies concerned. There is little or no university training; the teacher training college is low-level.

Such a school system has still to develop its teachers, programs, textbooks, physical plant, administrators, and professional purpose. It cannot be counted as a major national resource in meeting manpower needs.

In these countries, ITV often preempts the educational system, determining the curriculum, the mode of instruction, the method of examinations, the training of the teachers, and even the architecture of the schools.

The most notable example of such a use of ITV is American Samoa, which is discussed by Dr. Schramm (above), but there are other cases.

In the Republic of Niger, with a rural population, 66 trained teachers, and about 5 percent of its school-age children in schools, educational authorities moved directly to television instruction for first grade students. French, a foreign language to these students, is the language of instruction, just as English is used for Samoan-speaking students in American Samoa. Primary school graduates, untrained as teachers, serve as classroom monitors, freeing the few available trained teachers to work at higher levels with the young men who will be senior government officials before they are 30. The experiment began with closed circuit classes in 1964, and will be transferred to open circuit television as soon as Niger's new television station begins operations. In due course, Niger hopes to offer the entire primary school curriculum by television.

Another African country, the Ivory Coast, uses television to teach the fundamental skills of reading and arithmetic to workers who are being trained as middle level supervisors. The workers have to be instructed during the working day when they can be reached. Television sets and improvised classrooms are provided in industrial plants, with lightly trained monitors supplementing the televised programs. From small beginnings in 1962, the program now has 23 viewing groups in Abidjan and 37 more in other parts of the country.

Togo, with only the brave beginnings of an educational system and no television station, uses radio to carry new ideas to a rural population that is beyond the reach of the nation's small cadre of teachers. As in many other

African countries, Togo has two urgent needs: to develop agriculture and the life of the villages as the first step in creating an effective labor force; and to establish one language -- French -- as the means of communication basic to education. Both needs are met through the rural forum, used successfully in other countries. The forum is a village meeting using radio instruction. It meets six times a week, with five days devoted successively to programs on rural economy, public health, the five year plan, education, and social affairs. The radio programs follow a uniform pattern: ten minutes of news, ten minutes of educational material, and fifteen minutes in French. The sixth session is for answering questions and reporting decisions reached by the village forums. The principal figure in the forum is the animateur, a local person trained for two or three days and returned to his village to select the other members of the forum, preside over discussions, and report on attendance, questions, problems, and decisions.

There were 150 forums in 1965; the government anticipates 1,000 by the end of 1966; and, in time, when television adds a new dimension to communication, there will be more.

Similar uses of instructional television are found in school systems that are well developed but inaccessible to a segment of the population. Peru has a free and legally compulsory primary school program, but it does not reach about 15 percent of primary school age children. To reach them is the purpose of the Telescuola Popular Americana -- TEPA. TEPA began as a series of

programs in literary skills and basic arithmetic, using volunteer help and donated TV time. Later, more advanced work was added at one end of the scale, and a recreational program for pre-school children at the other. In addition to meeting the needs of some 800 students who would otherwise have no schooling, TEPA also offers adult literacy programs.

2. Nations With Partially Developed Educational Systems

Partially developed educational systems formally require compulsory elementary education, but the requirement is neither enforced nor enforceable, for lack of schools, teachers, and transportation. The system normally has few secondary schools and a legally controlled system of apprenticeship which resists the incursion of formal training in the crafts and trades. Higher education is typically European in tradition and accommodates a limited number of favored students who plan to enter traditional professions. Such systems offer a limited range of opportunity and virtually no adult education.

Here, instructional television is often both embraced and resisted. The embrace is likely to come from the Ministry of Education seeking to reach unreachable students. Resistance may come from intellectuals grouped around the university who oppose mass education because they believe it will increase educational costs (at the expense of university development) and lower educational standards.

Nonetheless, ITV is often used extensively to improve elementary education. In addition, there is limited use of closed circuit television in the

universities for students who overflow the lecture halls; a more extensive use of television along with other media in raising literacy and in improving rural life; and substantial use of government controlled non-commercial stations for information, for cultural purposes, and for propaganda. Programs are often broadcast in the several languages spoken in the nation to promote a sense of national unity.

In Taiwan, a group led by a Jesuit priest has used television for elementary and pre-vocational instruction for several years, cooperating with the Ministry of Education and using obsolete equipment donated by American TV stations. Broadcasts of low power serve public and private schools in and near Taipei. The station also serves as a training center for producing and using learning materials, a function that will become more important as large numbers of elementary students move into overcrowded secondary and vocational schools.

Colombia is using television to upgrade the quality and expand the content of instruction in the first five grades. Each receives ninety minutes of television instruction a week. Teacher orientation programs are broadcast for an additional ninety minutes a week. The number of broadcast hours is being increased as the programs become more effective. The program, financed in 1964 with assistance from the United States Agency for International Development, is substantial and operates through a semi-autonomous institute -- the Institute National de Radio y Television. In 1965, the programs reached an estimated

13 percent of Colombia's primary school pupils. It is still expanding, although slowly because of maintenance problems and loss of equipment.

Nigeria has also attempted to upgrade and extend elementary instruction with television. The problems have been overwhelming. Stations established by the Government are expected to broadcast educational materials at least half the time, but the commitment is seldom kept because the stations become commercially oriented. An uncertain power has interfered with operations, sets have broken down and disappeared, and teachers used to conventional methods have consistently refused a central role to television, preferring to use it as a supplement. The program has stayed alive for six years despite its difficulties, which itself testifies to its value. More important, there is impressive testimony that instruction has improved.

In Thailand, with a shortage of trained teachers and a need to introduce new subjects, the pilot effort to improve elementary school instruction depends on radio. In 1954, a home service of sixteen hours a week was broadcast in the early evening for school children, teachers, and the general public. After several years of trial and evaluation, a decision was made that three subjects -- English, music, and social studies -- could usefully be taught by radio. School broadcasts to 286 began in 1958, and have been enlarged until at present they reach 5,000 school and 80,000 pupils. Music and social studies are still taught in the first four grades; English has been expanded to six grades. In addition, there is a daily lunchtime program for students and a thirty minute program for teachers twice a week.

The successful use of radio instruction, including staff training, has paved the way for a decision to move into television. At present the Ministry is producing two half-hour TV programs a week broadcast from commercial TV stations, and is examining further expansion.

Although the needs of secondary and vocational education are great in nations with partially developed school systems, surprisingly little use of ITV is made at these levels. Rather, attention is directed to the problems of illiteracy, rural life, and elementary education, with a stress on teacher training.

3. Nations With Developed Educational Systems

In nations with well-developed school systems and well-established broadcast organizations, instructional television has been a latecomer without clearly defined tasks. It has tended to find its way into the educational complex from around the edges, providing "reinforcement" or "enrichment" for existing programs. Experiments with new courses have, for the most part, been forced to compete with existing offerings and schedules. Few have been central to any program of instruction.

Three nations are exceptions to the rule and have found significant uses for televised instruction.

In France, television is made available to villages too isolated to enjoy any sustained contact with contemporary society, and too poor to afford any form of group entertainment. A tele-club is organized in each village that can, as a

group, buy and maintain a large television set. Centrally located, the set serves the entire population.

With modest financial support, the tele-clubs have spread rapidly. Some television programming is especially directed to them. This programming is, in effect, adult education -- the forerunner of many television and radio programs in rural areas. Among the countries that have accepted this concept are Japan, India, Colombia, Peru, Niger, Honduras, Togo, and the Ivory Coast.

Italy developed another instructional use for television. Extension of universal education to ten years was hampered by a shortage of teachers and classrooms. Televised instruction was used; the supervision of the group, the enforcement of assignments, and the reinforcement of the televised instruction (using prepared materials) was left to classroom monitors trained as primary school teachers. In addition to teaching students, the program upgraded the teachers.

In Japan, where there are more candidates for admission to the upper grades of secondary school than can possibly be accommodated and where social mobility is a universal desire, the educational answer is a supervised correspondence program which either stands alone or is supplemented by radio or television or both. Television is considered such an important element in the program that students are offered special inducements to make use of it.

Japan also uses television for adult education in agricultural areas.

This experiment, initiated in 1956, was designed to improve rural life by introducing new ideas in an attempt to modify the rigid and essentially feudalistic village structures. The experiment required developing a new form of group organization in the test villages, training leaders, introducing the unfamiliar television sets as the vehicle of communication, and introducing ideas and methods that departed from tradition. It has been successful and is now the basic method of reaching the rural population.

Conclusion

Television and radio are being used to help meet a variety of educational needs, in and out of school -- to upgrade classroom instruction, to teach teachers, to extend the school, to teach literacy and fundamental education and community-development information. They are being used in all regions of the world and in all kinds of countries and cultures. When their use is significant, it is in combination with other learning resources and experiences, such as monitors and discussion groups, special reading materials and exercises, and correspondence work. Television and radio are seldom effective alone.

Finally, as the most sophisticated medium, television combines the virtues of correspondence and of radio and, in addition, conveys a sense of immediacy and human presence that other media cannot offer. It can outreach them all in effectiveness. . Television, when it can be afforded, meets instructional needs that can be met in no other way.

Respectfully submitted,

The Ford Foundation

by McGeorge Bundy
McGeorge Bundy, President

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In the Matter of the

Establishment of domestic communications
satellite facilities by non-governmental
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No. 16495

REPLY LEGAL BRIEF

REPLY LEGAL BRIEF AND COMMENTS OF THE FORD
FOUNDATION IN RESPONSE TO PARAGRAPHS 4(a) AND
4(b) OF THE COMMISSION'S NOTICE OF INQUIRY OF
MARCH 2, 1966, AND PARAGRAPHS 3(b), 3(c) (5), AND
3(d) OF THE SUPPLEMENTAL NOTICE OF INQUIRY OF
OCTOBER 20, 1966.

Ginsburg and Feldman
Washington, D. C.

December 12, 1966

Attorneys for the
Ford Foundation

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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INTRODUCTION

The Ford Foundation established three basic propositions in its legal brief* concerning paragraphs 4 (a) and 4 (b) of the Commission's March 2, 1966, Notice of Inquiry. These propositions demonstrate the Commission's power to authorize a national non-profit corporation transmitting radio and television via satellite, as proposed by the Foundation.

First, the Communications Act of 1934 empowers the Commission to authorize private non-common carriers to construct and operate communications-satellite facilities to meet their specialized domestic needs. Analysis of the language of the 1934 Act, its legislative history, and judicial and Commission decisions interpreting it, makes clear that the Act provides the Commission with this power. A national non-profit corporation along the lines proposed by the Foundation would particularly serve the aims of the 1934 Act, as amended in 1962, because the corporation's purpose would be to promote educational television.

Second, neither the 1962 Communications Satellite Act nor the 1964

*Legal Brief and Comments of the Ford Foundation in Response to Paragraphs 4 (a) and 4 (b) of the Commission's Notice of Inquiry of March 2, 1966, In the Matter of the Establishment of Domestic Non-Common Carrier Communications-Satellite Facilities by Non-Governmental Entities, hereinafter referred to as "the Foundation's August 1 Legal Brief."

The Comments of the Ford Foundation in response to the other paragraphs of the Commission's March 2, 1966, Notice of Inquiry are hereinafter referred to as "the Foundation's August 1 Comments."

International Agreements preclude exercise of the Commission's power. To the contrary, section 102 (d) of the 1962 Act expressly provides that, "It is not the intent of Congress by this Act . . . to preclude the creation of additional communications satellite systems, if required to meet unique governmental needs or if otherwise required in the national interest." The 1964 Agreements, like the 1962 Act, were aimed solely at creating a system to serve international needs, not the system to serve the domestic requirements of more than 50 signatory nations.

Third, establishment and operation of communications-satellite facilities by a non-profit corporation for national non-commercial and commercial television, as proposed by the Foundation, would meet the tests of "public convenience, interest, or necessity," under the 1934 Act, and "required in the national interest," under the 1962 Act.

Each of these points was discussed in detail in the Foundation's August 1 Legal Brief. In order to present a complete picture of the issues involved, however, Part 1 of this Reply contains a summary of that Brief.

Most of the August 1 submissions by other interested parties, including AT&T and ITT World Communications, Inc., agreed with the basic legal position of the Foundation -- the Commission has the power to authorize private non-common carriers to construct and operate communications-satellite facilities to meet their specialized domestic communications needs -- although several questioned the wisdom of such authorizations. Four parties, however,

concluded that the Commission lacked power to authorize these facilities.

Part 2 of this Reply responds to each of the points raised in the submissions of those parties.

Part 3 of this Reply responds to the legal issues raised in the Commission's October 20, 1966, Supplemental Notice of Inquiry. First, it examines, in accordance with paragraph 3 (b) of the Supplemental Notice:

Whether, as a matter of law, there is any restriction on the Commission's power to authorize any communications common carrier or carriers to construct and operate communication satellite facilities for domestic communications services (Emphasis added.)

Second, it discusses, in accordance with paragraph 3 (c) (5) of the Supplemental Notice, issues that would arise if there were common control over domestic and international satellite communications. Finally, paragraph 3 (d) of the Supplemental Notice invites comments on whether the arrangement proposed by the Foundation may be licensed under present statutes, and, if not, what type of legislation might be needed. The Foundation's position is that no new legislation is necessary, and its reasons are set forth in the first two Parts of this Reply. On the assumption that the Commission might consider a new statute advisable, Part 3 also identifies issues that might be dealt with in the legislation.

Several other legal questions that concern Commission regulation arose in forums outside this proceeding, including hearings before the Senate Commerce Committee. These questions are considered in Part 4 of this Reply.

PART 1 -- SUMMARY OF THE
FOUNDATION'S LEGAL POSITION

(A) The Communications Act of 1934.

A Commission grant of authority to the proposed non-profit corporation would fall squarely within the terms of the 1934 Act. "R/egulatory power over all forms of electrical communication" is granted to the Commission under the Act. S. Rep. No. 781, 73rd Cong., 2d Sess., at 1 (1934). Communication by satellite is, of course, a form of electrical communication. Moreover, the Commission is authorized to "generally encourage the larger and more effective use of radio in the public interest." (47 U.S.C. § 303 (g)*.) A national non-profit corporation transmitting commercial and non-commercial television would serve precisely this purpose. The policy behind section 303 (g) was stated during the Congressional hearings on the Act: "Our supremacy in radio cannot be maintained except by active encouragement and development of its use. Its possibilities are almost untouched today Who knows what future developments may bring?" Hearings on H.R. 8301 Before the House Committee on Interstate and Foreign Commerce, 73rd Cong., 2d Sess., at 21 (1934).

Authorization for a satellite service to promote national, non-commercial television broadcasting -- as proposed by the Foundation -- would particularly serve the policies of the 1934 Act. Sections 390-97, added in 1962, authorize

*All subsequent citations to the 1934 Act are to 47 U.S.C. (1964).

federal grants for "provision of educational television broadcasting facilities which will serve the greatest number of persons and serve them in as many areas as possible, and which are adaptable to the broadest educational uses." (Section 392 (d) (3).) Section 395 authorizes the Commission to assist the Secretary of Health, Education, and Welfare in promoting educational television.

Interpretation of the 1934 Act to permit a Commission grant of authority to the proposed non-profit corporation is supported by the Commission's judgment five years ago that it had power to authorize private use of communication satellites. In 1961 the Commission issued a notice of inquiry into the general topic of the commercial use of communication satellites. One of the issues specifically raised was whether the Commission had statutory power to proceed in this area. See Inquiry into the Administrative and Regulatory Problems Relating to the Authorization of Commercially Operable Space Communications Systems, para. 5 (3), F.C.C. Docket No. 14024 (March 29, 1961). All responses to the notice of inquiry concluded that the Commission did have such power. As Chairman Minow stated, "No one at that time suggested that any legislation was needed." Hearings on Communications Satellites Before the House Committee on Interstate and Foreign Commerce, 87th Cong., 1st Sess., pt. 1, at 86 (1961). Before the Commission was able to consider concrete plans for a communications-satellite system, Congress began the investigation that ultimately led to the Communications Satellite Act of 1962. The legislative history of that Act, however, reveals general agreement among those who

considered the point that the Commission had power under the 1934 Act to authorize communication satellites for commercial use. As Chairman Minow testified on behalf of the Commission, "The law would permit us to license a private user for space satellite communications." Hearings on Space Satellite Communications Before the Subcommittee on Monopoly of the Senate Select Committee on Small Business, 87th Cong., 1st Sess., at 662 (1961). Statements by Congressmen and various officials in the Executive Branch were in accord with that position. See, e.g., Hearings on Communications Satellites Before the House Committee on Interstate and Foreign Commerce, 87th Cong., 1st Sess., pt. 1, at 153, 177 (1961).

Prior judicial and Commission decisions also support this view. The Commission has consistently maintained that the 1934 Act gives it ample authority to meet changing circumstances and the demands of a rapidly developing technology, see, e.g., Amendment of Rules to Provide for Subscription Television Service, 23 F.C.C. 532, 536 (1957), and the courts have regularly supported this view. In FCC v. Pottsville Broadcasting Co., 309 U.S. 134, 138 (1940), for example, the Supreme Court said that underlying the 1934 Act "is recognition of the rapidly fluctuating factors characteristic of the evolution of broadcasting and of the corresponding requirement that the administrative process possess sufficient flexibility to adjust itself to these factors."

Lower courts have uniformly followed this approach in applying the Act to new technological developments. They have, for example, affirmed the

Commission's assertion of plenary power over television broadcasting, although in 1934, when the Act was passed, Congress was unaware of the impending utilization of television. See e.g., People's Broadcasting Co. v. United States, 209 F.2d 286, 287 (D.C. Cir. 1953). Similarly, the Commission authorized a three-year trial use of subscription television in 1957 although in 1934, the reception of radio broadcasts had always been without charge. See Amendment of Rules to Provide for Subscription Television Service, 23 F.C.C. 532 (1957).

(B) The Communications Satellite Act Of 1962.

The language of the 1962 Act and its legislative history make clear that its primary purpose was to establish "a commercial communications satellite system" (section 305 (a) (1)), not the system, and the arrangement envisaged was international not domestic. Section 102 (a), for example, states that the Act was intended as a major step toward "an improved global communications network." The legislation should not, therefore, be read as precluding private domestic systems.

Two considerations caused Congress to focus almost exclusively on international communications. First, an international system was seen as a means both to move ahead of the Soviet Union, which had apparently taken the lead in space technology, and to enable the United States to assert a position of leadership at the Extraordinary Administrative Radio Conference of the International Telecommunications Union called in 1963 to allocate frequencies for communications-satellite systems. See H.R. Rep. No. 178, 89th Cong., 1st Sess. 22 (1965).

Second, in 1962 non-synchronous satellites patterned on Telstar were seen as the model for many years to come. Since such satellites orbited the globe they made sense only in the context of an international system. Moreover, the high cost of a satellite system, as projected in 1962, made it economically attractive only as an alternative to costly submarine cables. See, e.g., Hearings on Communications Satellites Before the House Committee on Interstate and Foreign Commerce, 87th Cong., 1st Sess., pt. 1 at 4-5 (testimony of Chairman Minow) (1961). At the same time, however, Congress realized that flexibility was an absolute necessity, and that although domestic communications services by satellite seemed unlikely in the foreseeable future, new developments might make such services feasible. On this basis, Congress expressly provided in section 102 (d):

It is not the intent of Congress by this Act to preclude the use of the communications satellite system for domestic communication services where consistent with the provisions of this Act nor to preclude the creation of additional communications satellite systems, if required to meet unique governmental needs or if otherwise required in the national interest.

This section recognizes that: (1) The international system envisaged in the statute might be used for domestic services if this could be done in a manner consistent with the other obligations imposed on Comsat by the Act; and (2) Other systems might be established "to meet unique governmental needs or if otherwise required in the national interest."

The legislative history of section 102 (d) makes clear that Congress did

not intend to preclude Commission authorization of additional communications-satellite systems. When the legislation was first passed by the House, section 102 (d) had been amended to provide:

The Congress reserves to itself the right to provide for additional communications satellite systems if required to meet unique governmental needs or if otherwise required in the national interest.

See H.R. 11040, as passed by the House of Representatives on May 3, 1962, and introduced in the Senate on May 4, 1962. The Senate refused to accept this language, however, and substituted the current version of section 102 (d). The House then acceded to the Senate's version. The Congress has thus already considered and rejected the position that further legislation is a prerequisite to Commission authorization of additional domestic facilities.

(C) The 1964 International Communications Satellite Agreements.

Like the 1962 Act, the Inter-Governmental Agreement and the Special Agreement, concluded in August 1964, were designed to establish "a global commercial communications satellite system." T.I.A.S. No. 5646 (1964). Nothing in the language of either instrument could be interpreted as precluding separate domestic systems.* They were aimed at creating a system to serve international needs, not the system to serve the domestic requirements of more than 50 signatory nations.

*The Inter-Governmental Agreement is relevant as a matter of policy but does not affect the Commission's legal power under the 1934 Act since the Agreement is not a treaty.

(D) The "Public Interest" Test Under The 1934 Act And The "National Interest" Test Under The 1962 Act.

Section 102 (d) of the 1962 Act requires applicants for private communications-satellite systems to demonstrate that their proposed services are "required in the national interest." The 1934 Act demands a showing of "public convenience, interest, or necessity." (E.g., sections 303, 307.) There are no other limitations on the Commission's power to authorize non-common carriers to construct and operate domestic communications-satellite facilities.

Precedents or regulations under the 1962 Act concerning what is "required in the national interest" have not yet been developed. We believe, however, that promoting non-commercial television meets the standard.

Members of the Commission, Congress, and the Executive have all emphasized the need for rapid development of educational television. In Chairman Hyde's words:

Telelevision represents a breakthrough in means of communicating light and knowledge comparable in significance to the development of the printing press and as indispensable to improvement of educational techniques as the latter.

Hearings on Educational Television Before the Communications Subcommittee of the Senate Committee on Interstate and Foreign Commerce, 87th Cong., 1st Sess., at 121 (1961).

The issue is not just the number of non-commercial stations or the

number of hours a week of programming. If non-commercial television is to realize its potential, there must be a national non-commercial network as well as funds for creative programming. See, e.g., Hearings on Educational Television Before the Communications Subcommittee of the Senate Committee on Interstate and Foreign Commerce, 87th Cong., 1st Sess., at 118 (statement of former Commissioner Ford) (1961).

Experience has revealed that the cost of establishing a network with terrestrial facilities is prohibitive for non-commercial television. The Foundation's proposal demonstrates that a communications-satellite system, properly organized, can eliminate this barrier. The authoritative analysis of the feasibility of educational television by satellite is a detailed report recently prepared for UNESCO by a team of experts from Stanford University. Schramm, et al., A Pilot Test of An Educational Television Satellite (Draft, May 1966). The authors conclude that it is both economically and technologically practical to develop a full-scale system of educational television by satellite.

Furthermore, the Commission's conclusions in Allocation of Microwave Frequencies Above 890 Mc., 27 F.C.C. 359 (1959), 29 F.C.C. 825 (1960) (reconsideration), apply equally here:

There is every reason to believe that message services of the Bell System will continue to provide its life blood and raison d'etre Accordingly, it would appear reasonable to anticipate that any losses of message toll and private line revenues that the Bell System may incur because of the establishment of private communications systems will be more than offset by the revenues that will accrue to the Bell System in the normal course of development of its other sources of revenue.

29 F.C.C. at 852 (1960). The economic impact of the Foundation's proposal on domestic common carriers will be negligible. Referring specifically to the Foundation's proposal, AT&T recently told its stockholders that:

The business of transmitting radio and TV programs accounts for only a very small part of Bell System revenues.

American Telephone and Telegraph Company, Share Owners' Quarterly, September 19, 1966. The potential economic impact on Comsat is more difficult to assess. First, international communications are developing at a rapid rate; historically, projected needs have been underestimated. Second, implementations of the Intra-Governmental Committee's recommendation for permissive merger legislation may well enhance Comsat's position in international communications. See Intra-Governmental Committee on International Communications, Report and Recommendations to the Senate and House Commerce Committees 31-33 (April 1966).

The courts have applauded the Commission's refusal to "let its decisions in the radio carrier field interfere with its responsibilities in the television broadcasting field." Carter Mountain Transmission Corp. v. F.C.C., 321 F.2d 359, 362 (D.C. Cir.), cert. denied 375 U.S. 951 (1963).

Finally, Commission authorization for a non-profit corporation to transmit television broadcasts by satellite would accord with the Commission's traditional concern for the development of new and different non-profit enterprises. See Amendment of the Commission's Rules to Permit Expanded

Cooperative Sharing of Operational Fixed Stations, F.C.C. Docket No. 16218,
at 12 (July 15, 1966).

* * *

For these reasons: (1) The Commission has the power under the 1934 Act to authorize private non-common carriers to construct and operate communications-satellite facilities to meet their specialized domestic needs; (2) Neither the 1962 Act nor the 1964 International Agreements removed this power; and (3) The facilities proposed by the Foundation would meet the tests of "public convenience, interest, or necessity" under the 1934 Act and "required in the national interest" under the 1962 Act. The Commission should, therefore, view its statutory and regulatory powers as permitting authorization of the proposed facilities.

PART 2 -- REPLY TO ARGUMENTS BY OTHER PARTIES

(A) The 1962 Act Was Not Intended As Comprehensive Legislation
Governing United States Participation In All Aspects Of Domestic Communication
By Satellite.

None of the parties responding to the Commission's March 2, 1966, Notice of Inquiry questioned the Commission's power under the 1934 Act to authorize private non-common carriers to construct and operate communications-satellite facilities to meet their specialized domestic communications

needs.* However, Several of the initial submissions argued that the Communications Satellite Act of 1962 precluded Commission authorization of such facilities. The Hawaiian Telephone Company Brief, for example, states: "The Communications Satellite Act of 1962 . . . was intended as a comprehensive piece of legislation to cover all participation by United States entities in communications satellite systems." (Page 1.)

Both the language of the 1962 Act and its legislative history are to the contrary. They make clear that Congress considered the Act a means to promote "a commercial communications satellite system," (section 305 (a) (1)) not the only system, and that the arrangement envisaged was international not domestic.

Section 102 (a), for example, provides that the Act is intended as a major step toward a "global communications network." Throughout the entire Congressional consideration of the measure, it was viewed as a means "to bring into being a private corporation which would be the U.S. participant in a global satellite communications system." H.R. Rep. No. 1636, 87th Cong., 2d Sess. 7 (1962).

As discussed above, there were two reasons why Congress chose to pass special legislation concerning international -- but not domestic -- communications by satellite. First, in 1962 attention was focused on non-synchronous

*The GT&E Brief may be read as arguing that the Commission was not granted this power under the 1934 Act. (See page 3.) In context, however, the GT&E position seems to be that the 1962 Communications Satellite Act pre-empted the entire field of United States participation in communications-satellite activities. The Commission's power under the 1934 Act is discussed in full in the Foundation's August 1 Legal Brief, pages 4-14, and summarized supra, pages 3-7.

satellites patterned on Telstar. Since such satellites would be usable by any one country only a small part of each day, they made sense only in the context of an international system. Moreover, the estimated costs of a satellite system in 1962 were so high that it was economically attractive only as an alternative to costly submarine cables. See, e.g., testimony of Chairman Minow in Hearings on Communications Satellites Before the House Committee on Interstate and Foreign Commerce, 87th Cong., 1st Sess., pt. 1, at 4 (1961).

Second, an international system was seen as an important goal of United States foreign policy, in terms of United States leadership in space technology and specifically in terms of the United States role at the Extraordinary Administrative Radio Conference of the International Telecommunications Union called in 1963 to allocate frequencies for communications-satellite systems. See, e.g., H.R. Rep. No. 178, 89th Cong., 1st Sess. 22 (1965).

It is true, of course, that "The Commission does not have the power, under the Communications Satellite Act of 1962 . . . to authorize non-governmental non-common carrier entities to construct and operate communication-satellite facilities for the purpose of meeting their private or specialized domestic space communications requirements." (GT&E Brief, page 1.) The 1962 Act does not, by itself, empower the Commission to authorize the construction and operation of domestic communications-satellite facilities. But that is not the issue. The Commission's authority derives from the 1934 Act; the question is whether the 1962 Act diminished that authority. Section 102 (d)

expressly provides that the Act does not "preclude the creation of additional communications satellite systems, if required to meet unique governmental needs or if otherwise required in the national interest." And, as stated in the August 1 Brief of the National Association of Manufacturers Communications Committee, power granted by Congress to a government agency continues in the absence of a clear statement of legislative intent to remove that power. See, e.g., Federal Trade Commission v. A.P.W. Paper Co., 328 U.S. 193, 202 (1946). (For further discussion of Section 102 (d), see Part 2 (C) of this Reply, infra, pages 18-22.)

The 1962 Act was not, therefore, intended as "comprehensive legislation" concerning United States involvement in all communications via satellite but only international satellite communications. For this reason, the legislation should not be read as precluding private systems serving specialized domestic needs only. (For further discussion of this point, see the Foundation's August 1 Legal Brief, pages 14-18.)

B. The Reasons That Prompted Congress To Adopt A Special Regulatory Scheme In The 1962 Act Are Not Necessarily Applicable To Domestic Communications-Satellite Services.

The Comsat Brief suggests that "It would have been anomalous for Congress to have imposed . . . detailed safeguards on one entity (i.e., Comsat) while leaving other entities who are not even authorized carriers and would be subject to a less comprehensive and less stringent scheme of regulation, to engage in

substantially identical activities wholly without regard to such safeguards."

(Pages 12-13.)

This suggestion ignores both the unique character of Comsat and the unique character of the problems -- not present here -- that Congress sought to solve by the 1962 Act.

In the 1962 Act, Congress granted Comsat a complete monopoly over all United States participation in the field of international communications by satellite. In establishing a carriers' carrier with monopoly control over international satellite communications, Congress naturally created special safeguards to insure that its legislative purposes would be met. However, non-common carriers that might receive Commission authorization to establish domestic communications-satellite facilities would not be in positions similar to Comsat's. They would be neither monopolists nor carriers' carriers. There would be no need, therefore, for the safeguards that Congress provided in the 1962 Act.

The 1962 Act makes clear that Congress wanted to protect United States foreign-policy interests. Thus, for example, Comsat must notify the Department of State whenever it negotiates with any international or foreign entity (section 402); the President must exercise "supervision over relationships of the corporation with foreign governments or entities or with international bodies" (section 201 (a) (4)); and the Commission must act on the Secretary of State's advice that "commercial communication to a particular foreign point by

means of the communications satellite system and satellite terminal stations should be established in the national interest" (section 201 (c) (3)). None of these foreign-policy safeguards in the 1962 Act have any bearing on a domestic satellite communications system.

If special safeguards are appropriate for domestic services, the Commission has power to establish them under the 1934 Act. Section 303 (r) specifically directs the Commission to "make such rules and regulations . . . as may be necessary to carry out the provisions of this chapter" Regulations can be issued under this mandate to provide whatever safeguards the Commission believes advisable.

At any time, of course, Congress could adopt legislation imposing a new regulatory scheme on the establishment and operation of domestic communications by satellite. But until Congress acts, the Commission retains full power under the 1934 Act to authorize facilities for such communications.

(C) Section 102 (d) Of The 1962 Act Recognizes The Commission's Power To Authorize Private Communications-Satellite Systems.

Section 102 (d) provides:

It is not the intent of Congress by this Act to preclude the use of the communications satellite system for domestic communication services where consistent with the provisions of this Act nor to preclude the creation of additional communications satellite systems, if required to meet unique governmental needs or if otherwise required in the national interest.

The Comsat Brief says that section 102 (d) "was intended as a declaration

of Congressional policy to establish the broad criteria which would guide Congress in the creation of any additional satellite systems and to make it clear that Congress was reserving the power to do so." (Pages 7-8.) The first part of section 102 (d) empowers the Commission to authorize domestic use of the international system. See S. Rep. No. 1584, 87th Cong., 2d Sess. 14 (1962).*

The second part of the section and its legislative history, however, make clear that Congress was not creating a domestic monopoly for Comsat.

First, the section provides that it "is not the intent of Congress by this Act . . . to preclude the creation of additional communications satellite systems, if required to meet unique governmental needs or if otherwise required in the national interest." It does not provide that Congress reserves the right to establish additional systems. A reservation would have been unnecessary both because section 301 provides that "The right to repeal, alter, or amend this Act at any time is expressly reserved," and because one Congress cannot

*"Subsection (d) originally read that it is not the intent of Congress to preclude the creation of additional communication satellite systems, if required to meet unique governmental needs or if otherwise required in the national interest. The Senate Commerce committee amended this subsection to provide also that nothing in this act shall preclude the use of the system for domestic communication services where consistent with the provisions of the act. This clarification was made to avoid any possible inference that may be drawn from the other provisions of the bill that Congress had made a policy determination that use of the system be limited to international communications. While it is unlikely that the system will be usable initially for domestic services in the United States because of technical and economic limitations, it is conceivable that eventually use of the system for domestic services may become feasible and entirely consistent with the act."

bind successive Congresses.* Thus, section 102 (d) must be read as an affirmation of the Commission's authority under the 1934 Act and not as a reservation of Congressional power.

Second, when the legislation was first passed by the House, section 102 (d) provided:

The Congress reserves to itself the right to provide for additional communications satellite systems if required to meet unique governmental needs or if otherwise required in the national interest.

See H.R. 11040, as passed by the House of Representatives on May 3, 1962, and introduced in the Senate on May 4, 1962. If Congress had adopted the House version, further legislation would be required before additional domestic facilities could be developed. The Senate refused to accept the House language, however, and substituted the current version of section 102 (d). The House acceded. Defeat of the House language shows that Congress considered and rejected the position that further legislation is a prerequisite to Commission authorization of domestic facilities.

Third, the debates on the 1962 Act indicate support, among those who considered the matter, for the view that the Commission has the power to authorize domestic private communications-satellite facilities. Senator Church,

*As stated in AT&T's brief, "Not only does one Congress lack power to bind successor Congresses in the exercise of their legislative functions, but § 301 of the Satellite Act expressly provides that 'The right to repeal, alter, or amend this Act at any time is expressly reserved.' It follows that if the power to create additional satellite systems is deemed to reside only in the Congress, the establishment of specific standards for the exercise of that power would be meaningless, since it could not possibly have any binding effect." (Pages 2-3.)

the only member of Congress to speak at length on section 102 (d), stated:

The wisdom of the last clause of section 102 (d) 'or if otherwise required in the national interest' is perfectly apparent. We cannot now foretell how well the corporate instrumentality established by this act will serve the needs of our people. If it should develop that the rates charged are too high, or if the service too limited, so that the system is failing to extend to the American people the maximum benefits of the new technology, or if the Government's use of the system for Voice of America broadcasts to certain other parts of the world proves to be excessively expensive for our taxpayers, then certainly this enabling legislation should not preclude the establishment of alternative systems, whether under private or public management. And just as certainly is that gateway meant to be kept open, just in case we should ever have to use it, by the language to be found in the bill's declaration of policy and purpose to which I have referred.

108 Cong. Rec. 16362 (1962) (Emphasis added).

Moreover, in response to Senator Kefauver's concern about businesses that need communications-satellite services but "don't want to make a deal with a communications carrier," then Assistant Attorney General Katzenbach said:

Then they have to get into the business themselves, sir. And I suppose if that is a practicable way of doing it, then that is what should be done. But these are responsibilities as to who is to be licensed for what purposes, which are given to the Federal Communications Commission.

Hearings on Antitrust Problems of the Space Satellite Communications System Before the Subcommittee on Antitrust and Monopoly of the Senate Committee on the Judiciary, 87th Cong., 2d Sess., pt. 1, at 55-56 (1962).

The GT&E Brief contends "that the separate systems spoken of in the above Section 102 (d) include only governmental systems owned and operated by and for the benefit of the United States Government This provision has been so interpreted by this Commission. (See Memorandum Opinion and Statement of Policy released July 21, 1966, in Docket No. 16058 at paragraph 25 the Authorized User proceeding.)" (GT&E Brief, page 6.)

Paragraph 25, cited by GT&E, does not suggest that "national interest" is applicable to Government systems only. It simply confirms that the phrase covers such systems as well as private ones. The paragraph is part of a section dealing with "The Government's position as Authorized User - GSA's Contentions." The sole issue is the Government's use of Comsat's services, not use by private parties.

In this context, the Commission stated in paragraph 25, inter alia, that:

We believe that the standard for direct dealings between Comsat and the Government is thus embodied in the Act in the sections dealing with the somewhat related question of a separate Government system -- namely, if such dealing is required to meet unique governmental needs, "or is otherwise required in the national interest."
(Section 201 (a) (6); Section 102 (d).)

This statement is completely consistent with the Foundation's position and the term "national interest" in section 102 (d) permits both private systems and Government systems that do not qualify under the "unique governmental needs" clause.

(For discussion of why the "national interest" would be served by authorizing a non-profit corporation to establish and operate communications-satellite

facilities, as proposed by the Foundation, see pages 25-35 of the Foundation's August 1 Legal Brief, and Parts 1 (D) and 2 (E) of this Reply, supra, pages 10-12, and infra, pages 24-25.)

(D) The Authorized User Decision Is Consistent With Authorization Of A Non-Profit Corporation Transmitting Radio And Television Services Via Satellite.

In July 1966 the Commission announced that non-common carriers, including the Government, could obtain channels directly from Comsat only in "unique or exceptional circumstances," in order to prevent "serious adverse consequences" to the well-being of the common carriers. Authorized User Proceeding, F.C.C. Docket No. 16058, Memorandum Opinion and Statement of Policy, at 15. The economic hardship to common carriers that the Commission sought to prevent in the Authorized User proceeding must be distinguished from the considerations involved in the present inquiry.*

First, the Authorized User proceeding was concerned with international communications, an area of special sensitivity because of the economic condition of the international record carriers. The Commission's Memorandum Opinion

*The GT&E Brief alleges that "To permit a private user to construct and maintain its own domestic satellite system would be inconsistent with the expressed legislative intent (citing the Commission's Memorandum Opinion and Statement of Policy in the Authorized User proceeding) If the United States Government is to be generally barred from leasing channels directly from Comsat, it follows a fortiori that a private non-common carrier entity should be barred from maintaining its own satellite system." (Page 6.)

and Statement of Policy in the Authorized User proceeding reveals that fact:

[T]he loss of [overseas revenues from leased circuits] could come close to wiping out completely the record carriers' earnings, unless the facilities could be immediately used for other services and produce substantial revenues, which appears unlikely.

Id. at page 16. The financial well-being of the international carriers is not at issue in the present inquiry.

Second, if non-common carriers had been declared authorized users, Comsat would have been in direct and continuous competition with the common carriers. The proposed national non-profit corporation would not in any sense compete with the carriers but would at most divert from them an insignificant portion of their business. The competitive-injury problem to be considered here, therefore, is not that of the Authorized User inquiry but rather that of Allocation of Frequencies Above 890 Mc., 27 F.C.C. 359 (1959), 29 F.C.C. 825 (1960) (reconsideration), which authorized non-common carrier microwave systems and rejected the carriers' plea for economic protection against the resulting losses of revenues.

Third, authorization of the proposed facilities would have no impact on the common carriers' preponderant source of income -- message revenues. The Authorized User proposals -- especially the proposal for Comsat to furnish channels directly to the Government -- would have resulted in significant erosion of the common carriers' revenues from this source.

(E) The Proposed National Non-Profit Corporation Transmitting Radio And Television Via Satellite Would Serve Both The "National" And The "Public" Interest.

The Comments of ITT World Communications, Inc., state that: "Clearly, in light of the diverse and highly competitive companies which conceivably have sufficient volume of communication requirement to justify economically the establishment of private satellite systems, the Commission would be faced with a serious problem as to where the line should be drawn if it countenanced the establishment of such systems." (Page 11.)

There are two answers to this contention: First, the satellite service proposed here is different in kind and will be vastly larger than any other; second, drawing difficult lines is the business of a regulatory agency.

Television transmission is not a borderline case. It will use the largest fraction of the total capacity of all projected satellite facilities. The Technical Plan proposed by Comsat for 1970, for example, suggests that about two-thirds of the capacity of its proposed system would be used for television transmission. (See pages 8, 10.) See generally Estep, Some International Aspects of Communication Satellite Systems, 58 Nw. U. L. Rev. 237, 260 (1963).

At this time, therefore, the Commission need not determine the precise nature of all future arrangements for all possible communications-satellite uses. It need only decide that radio and television broadcasting may be distinguished

from message and other services that might also employ satellite facilities.

Beyond this, the non-profit corporation proposed by the Foundation will promote educational television. It is difficult to conceive of an enterprise more clearly designed to serve the national and the public interest.

PART 3 -- LEGAL ISSUES RAISED
BY THE COMMISSION'S OCTOBER
20, 1966, SUPPLEMENTAL
NOTICE OF INQUIRY

(A) The Commission Has The Power To Authorize Common Carriers
As Well As Non-Common Carriers To Construct And Operate Domestic
Communications-Satellite Facilities.

In the Commission's October 20, 1966, Supplemental Notice of Inquiry
comments were invited on:

Whether, as a matter of law, there is any restriction
on the Commission's power to authorize any communi-
cations common carrier or carriers to construct and
operate communication satellite facilities for domestic
communications services

(Supplemental Notice of Inquiry, para. 3 (b).) (Emphasis added.)

We believe that the Commission is empowered to authorize common
carriers to construct and operate domestic communications-satellite facilities.
The Communications Act of 1934 does not differentiate between common carriers
and non-common carriers in inquiries such as this one, except in terms of
"public convenience, interest, or necessity." See Allocation of Microwave
Frequencies Above 890 Mc., 27 F.C.C. 359 (1959), 29 F.C.C. 825 (1960)

(reconsideration); cf. Amendment of Rules to Provide for Subscription Television Service, 23 F.C.C. 532 (1957). The Foundation's August 1 Legal Brief demonstrates the Commission's power under the 1934 Act to authorize non-common carriers to construct and operate communications-satellite facilities for domestic services; its power under the Act to authorize common carriers is no less clear.

Under the Communications Satellite Act of 1962 common carriers own 50% of Comsat's stock. An argument might be made that because common carriers -- unlike non-common carriers -- were thus granted an opportunity to participate indirectly in Comsat's affairs, Congress intended to exclude their competition with the corporation in domestic satellite communications. There appears no support for this position in the legislative history of the 1962 Act. It is doubtful that such a legislative purpose should be presumed. In any event, this issue becomes irrelevant if Comsat is precluded from the field of domestic communications by satellite because of its position in the international consortium. (See Part 3 (B) of this Reply, infra, pages 28-30)

It thus appears that the 1962 Act did not preclude Commission authorization of common carriers just as it did not preclude Commission authorization of non-common carriers. Common carriers and non-common carriers are both subject to the "public convenience, interest, or necessity" test of the 1934 Act and the "required in the national interest" standard of the 1962 Act. Differences might, of course, arise in the application of these statutory criteria to the two classes in particular cases.

The Foundation's August 1 Legal Brief, pages 25-35, and Part 1 (D) of this Reply, supra, pages 10-12, demonstrate that the non-profit corporation proposed by the Foundation would meet both criteria. Other proposals, whether by common carriers or non-common carriers, must be measured against these criteria on a case-by-case basis as specific proposals are made.

(B) Issues Raised By Common Control Over Domestic And International Satellite Communications.

Paragraph 3 (c) (5) of the Supplemental Notice requests interested parties to consider:

The effect or impact of any such authorizations . . . upon the obligations of the United States Government as a signatory to the Executive Agreement Establishing Interim Arrangements for a Global Commercial Communications Satellite System.

The Foundation's August 1 Legal Brief demonstrates that the Foundation's proposal is wholly consistent with the 1964 Inter-Governmental Agreement and with United States obligations under that Agreement. (See pages 24-25. See also Part 1 (C) of this Reply, supra, page 9. Concerning the consistency of the Foundation's proposal with the 1962 Act, see the Foundation's August 1 Legal Brief, pages 14-24, and Parts 1 (B) and 2 (A)-(C) of this Reply, supra, pages 7-9, 13-22.) In view of the Commission's inquiry, we here examine whether the proposal presented by Comsat in its August 1 submission is consistent with the Agreement.

It is not yet clear whether Comsat proposes to establish a domestic satellite system wholly independent of INTELSAT or whether Comsat intends in

some way to establish and maintain the domestic United States system as part of INTELSAT. Both approaches raise questions of propriety and policy.

Operation of an independent domestic satellite system would appear to conflict with Comsat's obligations under the 1964 Inter-Governmental and Special Agreements. The corporation has an obligation to devote itself to serving the best interests of the international system and all of its participants. Were Comsat to establish a separate domestic system, a conflict of interest might develop. At the least, the energies and resources of the corporation might be diverted from fulfilling its international role. More troublesome, the corporation would be faced with situations in which it could channel business either to the international system, earning only 61% of the profit, or to its own domestic system, earning 100%. A basic purpose of the 1962 Act was to enhance the prestige of the United States as leader of an international undertaking designed to "contribute to world peace and understanding." (Section 102 (a).) Even a possible conflict of interest on the part of Comsat could jeopardize this aim.

Incorporation of the United States system and the domestic systems of other countries into a single global system would raise other problems. Whatever merit there might be in a proposal for a world monopoly of satellite communications for both domestic and international purposes, it is predictable that some countries will wish to maintain the independence and individual integrity of their domestic broadcasting and communication systems. The United States Congress has been exceedingly careful to immunize our domestic communications

system from foreign control. This Congressional policy would have to be reexamined if domestic communications, including broadcasting, were to be subjected to international control. Second, for the United States to extend the jurisdiction and power of Comsat into the domestic sphere would present difficult problems for those who already regard Comsat's majority interest and managerial control in INTELSAT as excessive. Third, countries unlikely to generate much traffic may anticipate that Comsat's profits from United States domestic sources will assist in subsidizing their international communications. But to use profits from United States domestic traffic to subsidize such international satellite communications would present other difficult economic and policy questions.

We are aware that these and related questions are being considered in the preparations for the 1969 conference which will seek to establish definitive arrangements for an international global system. We understand that the United States position is now being formulated and will be crystallized within a relatively short time. It is apparent that all domestic satellite services must be compatible with the global system. We believe, however, that this is possible without any substantial delay in the development of such services. In our view, to defer this development until final arrangements are made for the global system would be both unnecessary and unwise. (Issues of national economic policy raised by the proposal in Comsat's August 1 submission are examined in Volume I, Part 2 of this Reply.)

(C) New Legislation Is Not Necessary To Carry Out The Foundation's Proposal.

Paragraph 3 (d) of the October 20, 1966, Supplemental Notice of Inquiry invites comments on:

Whether the type of entity and service contemplated by the Ford Foundation proposal may be licensed under present statutes, and, if not, the type of legislation that would be required.

We believe that the Commission has power under the 1934 Act to license the non-profit corporation proposed by the Foundation. The courts and the Commission have consistently held that the Act grants the Commission "comprehensive powers to promote and realize the vast potential of radio." NBC v. United States, 319 U.S. 190, 217 (1942). The Commission has met its responsibilities under this mandate whenever new technology has produced new means of telecommunication. For example, the Commission asserted plenary power over television although this medium was unknown when the 1934 Act was adopted. More recently, the Commission exercised its power to authorize educational-television broadcasts via aircraft. See Airborne Television Transmitters, F.C.C. Docket No. 15201, 5 Pike & Fischer R.R. 2d 1727 (1965), 6 id. at 1613 (1965) (reconsideration). And it is clear that the Commission has jurisdiction over telecommunications in space. See California Interstate Telephone Co. v. F.C.C., 328 F.2d 566 (D.C. Cir. 1964) (transmission into space is "foreign transmission" under section 153 (f) of the 1934 Act).

As indicated below, we believe that the Commission may regulate the proposed non-profit corporation under the 1934 Act either as a common or a non-common carrier. The 1934 Act grants the Commission both the authority needed to carry out such regulation and the flexibility needed to develop regulatory criteria.

The Foundation has made a major proposal designed to meet critical national needs. Although we believe new legislation is not required, the Commission may decide that it would be appropriate for the Congress to consider and resolve the various issues raised by the proposal.

If legislation is sought, we see two primary areas of interest with respect to rate regulation. First, the new legislation might supplement the 1934 Act's "just and reasonable" test (see infra, pages 34-35, 39-41) to provide explicit statutory standards to guide the Commission in regulating the proposed corporation's rates and charges. Second, the legislation might specifically authorize free transmission by satellite of non-commercial television.

A second area that might be covered by new legislation is the disbursement of funds. Within the near future the Carnegie Commission will submit to the President a major report discussing the financial needs of non-commercial television and how those needs may best be satisfied. In Volume I, Part 3 of this Reply, we discuss some of the issues that may arise in this connection. Beyond this, however, we think it best to wait for the considered judgment of the Carnegie Commission.

Finally, the organization and structure of the proposed corporation might be considered appropriate for legislative decision. Volume I, Part 3, of this Reply, discusses the details of the arrangement that we have in mind. To implement this proposal no legislation would be necessary. If legislation were considered advisable, however, a variety of alternatives ranging from general guidelines to a detailed statutory charter might be considered.

PART 4 -- COMMISSION REGULATION OF THE PROPOSED NON-PROFIT CORPORATION

Several legal issues have been raised outside this proceeding concerning Commission regulation of the proposed non-profit corporation. This Part contains a systematic examination of those issues.

(A) Background.

The Communications Act of 1934 granted the Commission a variety of important regulatory tasks with respect to common carriers and non-common carriers.

A communications "common carrier" is defined by section 153 (h) of the 1934 Act as "any person engaged as a common carrier for hire, in interstate or foreign communication by wire or radio or in interstate or foreign radio transmission of energy" In essence, therefore, a common carrier offers its facilities for hire to the general public. In contrast, a non-common carrier uses its communications facilities for its own operations. A delivery service that controls its truck drivers by radio and a non-profit joint venture providing

communications service for members' aircraft are non-common carriers. Telephone and telegraph companies and the Domestic Public Land Mobile Service (used to provide communications services for hire to business and professional persons) are typical common carriers.

1. Common Carriers. -- The Commission regulates not only the rates of common carriers but many of their other activities as well. A common carrier that proposes to expand its services, for example, must demonstrate to the Commission that the expansion will meet the test of "public convenience and necessity." (Section 214.) If a common carrier wishes to provide interstate service by radio, rather than by wire, it must obtain a radio license from the Commission. (Section 301.)

The Commission ensures that common carriers provide service at rates that: (1) Are "just and reasonable"; and (2) Do not constitute "unjust or unreasonable discrimination". (Sections 201 (b); 202 (a).) Section 201 (b) also provides, however, that:

Communications . . . may be classified into . . . press . . . and such other classes as the Commission may decide to be just and reasonable, and different charges may be made for the different classes of communications

Acting under this provision, the Commission has accepted Press Wireless, Inc., as a "limited" or "specialized" common carrier. See, e.g., Press Wireless, Inc. v. The Western Union Telegraph Co., 28 F.C.C. 358 (1960). This entity provides services to the press only.

A "just and reasonable" rate is one that covers expenses and provides a fair return on invested capital. See Wilson and Co. v. United States, 335 F.2d 788, 797-98 (7th Cir. 1964), remanded, 382 U.S. 454 (1966). A carrier is not, however, limited to any specified rate of return on a particular class of service as long as it receives a fair return on its business as a whole. See Chicago Board of Trade v. United States, 223 F.2d 348, 351 (D.C. Cir. 1955); R.C.A. Communications, Inc. v. United States, 43 F. Supp. 851, 858 (S.D.N.Y. 1942).

Common carriers must file their rates and rate classifications in tariffs with the Commission. (Section 203.) These tariffs are subject to Commission approval; the Commission is authorized to establish a new rate schedule if rates contained in a tariff fail to meet the statutory requirements. (Section 205.) Whenever a common carrier files a new tariff, the Commission may hold a hearing to determine the reasonableness of the proposed charges. A hearing may be held either at the request of a complainant or on the Commission's own initiative. (Section 204.)

The first step in determining the reasonableness of an individual rate is an evaluation of the cost of providing the service in question. Based on the carrier's accounting records and whatever supplemental information is available, the Commission ascertains the carrier's operating expenses and the capital that the carrier has utilized in providing the service.

The second step is to determine the amount that a class of consumers must pay in addition to the cost of service. If the cost figures indicate that two customers have been charged different rates for the same service, the rates are discriminatory and hence unlawful unless they come within a statutory exception. Applying special rates to press users, for example, has been justified under section 201(b) on the ground that dissemination of news is an important public interest. See In the Matter of American Telephone and Telegraph, 34 F.C.C. 1094, 1098 (1963). On this basis, the Commission may authorize special rates to a particular user or class of users in order to serve a significant public interest.

Although reasonable return on investment is the major element in setting "just and reasonable" rates, other criteria, such as value of service, are sometimes considered. See Wilson & Co. v. United States, *supra*. If, for example, two carriers provide the same service in the same community they must, for competitive reasons, charge the same rates. At any rate level, however, the less efficient carrier will earn less on invested capital than the other carrier. The Commission must, therefore, consider a variety of other factors in passing on the reasonableness of their rates.

2. Non-common Carriers. -- Although the Commission does not regulate the rates of non-common carriers, it does regulate such carriers in other respects. All non-common carrier users of radio frequencies must obtain Commission approval of any proposed services. (Section 301.) The Commission

may analyze the nature of the service to be provided and the structure and organization of the entity providing it. Furthermore, it may require non-common carriers to renew their licenses periodically and to file accounts of their operations and finances. It may also refuse to renew a license for failure to meet the test of "public interest, convenience, and necessity." (Section 307(d).)

The category of non-common carriers known as cooperatives is especially relevant to the Foundation's proposal. In general, a cooperative is any group of users that provides communications facilities to meet its members' own needs. Many businesses have organized their own non-profit radio systems for member firms. These private sharing arrangements are increasing in number. They vary considerably in size. The largest, Aeronautical Radio, Inc., has more than 1250 ground radio stations and 40,000 miles of private lines. This co-operative provides communication channels for aircraft on a cost-sharing basis, although it has also provided free service to itinerant pilots. See Aeronautical Radio, Inc. v. A.T.A.T. Co., 4 F.C.C. 155, 159 (1937).

Many smaller organizations provide similar services to their members. For example, the Commission has licensed medical societies in California to operate radio stations for the purpose of contacting their members. The Forest Industries Radio Communications Association, under license from the Commission, operates in rural areas where distances are great and communications facilities nonexistent. See In the Matter of Amendment to permit expanded cooperative sharing of Operational Fixed stations, F.C.C. Docket No.

16218, at 6 (1966).

3. The Communications Satellite Corporation. -- The 1962

Communications Satellite Act vested the Commission with several regulatory functions concerning Comsat in addition to those found in the 1934 Act. The Commission must, for example ensure effective competition in the procurement of equipment for the international system. The Commission also supervises the operations of Comsat to make certain that authorized carriers have nondiscriminatory use and equitable access to the international system and that Comsat's rates are "just and reasonable." (These and other provisions of the 1962 Act applicable to Comsat are examined in Part 2 (B) of this Reply, supra, pages 16-18.)

(B) Discussion.

The Foundation anticipates that the proposed non-profit corporation (herein referred to as "BNSC") will be fully subject to Commission regulation, under existing laws and regulations, either as a common carrier or as a non-common carrier. The choice between these alternatives may be made by the commission and the interested parties at a later stage in the development of BNSC. We here consider some of the relevant issues.

1. BNSC as a Common Carrier. -- Common carriers normally offer services to the general public. One common carrier, Press Wireless, Inc., offers its services only to users transmitting material for publication and is regarded by the Commission as a "limited common carrier." See In the Matter

of Press Wireless, Inc., 17 Pike and Fischer RR 217, 223 (1956). BNSC, which will offer its services to broadcasters only, might also fall within this category. However, Press Wireless, Inc., is a commercial enterprise, distinguished from other common carriers only by its limited class of users. BNSC, as a non-profit enterprise concerned with non-commercial television, will have considerably less in common with traditional common carriers.

We believe that the 1934 Act would permit, but not require, that BNSC be treated as a limited common carrier. If BNSC were regarded as such a common carrier, several regulatory issues would arise.

The first is whether BNSC may provide channels for non-commercial television free of charge. Section 202 (a) of the 1934 Act prohibits common carriers from charging discriminatory rates unless they are determined to be "just and reasonable" by the Commission under section 201 (b). The basic purpose of this provision is to prevent one customer from obtaining a competitive advantage over another. This problem does not arise here: BNSC will treat all commercial users alike; non-commercial television is by definition non-profit. Moreover, the commercial networks will consent to the proposed arrangements for non-commercial television by agreeing to the charter of BNSC. Finally, non-commercial television like the press (which receives preferential rates from common carriers) serves a vital public function. See In the Matter of A. T. & T. Co., 34 F.C.C. 1094, 1098 (1963); In re Application of NTA Television Broadcasting Corp., 22 Pike & Fischer RR 273 (1961).

The Commission and the courts have generally interpreted the "just and

reasonable" standard as requiring rates that yield no more than a fair rate of return on investment. See Wilson & Co., v. United States, 335 F.2d 788, 798 (7th Cir. 1964), remanded, 382 U.S. 454 (1966). This presents a second issue --whether the proposed arrangement is compatible with that standard. The issue is avoided if rates charged by BNSC are no higher than those charged by a taxpaying concern entitled to a fair return on invested capital. As a non-profit corporation BNSC could then allocate its entire tax-exempt income to non-commercial television.

A harder problem is whether BNSC, if the Commission chose to regard it as a common carrier, would be by statute limited to a rate structure dictated by the standard of fair return on investment.

We think not. The Commission and the courts have interpreted the "just and reasonable" phrase of the statute as requiring a "fair rate of return on invested capital" in order to protect both stockholders and consumers. As a non-profit corporation, BNSC will have no stockholders expecting a return on their investment. The commercial networks will be its immediate consumers, but they will have consented, in a consortium agreement, to the BNSC rate structure. They will not, therefore, be obliged to look to the Commission for protection from excessive rates. This is a predicate of the Foundation's proposal.

The Commission may be concerned to ensure that rates charged advertisers by the commercial networks using BNSC are not excessive because advertising costs are, in turn, passed on to the consuming public. Ordinary

market forces will impose important constraints on advertising rates because the commercial networks must take into account the availability to their advertisers of other media. Further, the Commission has the authority to interpret the "just and reasonable" standard to take account of other relevant factors, including the effect of the proposed rates on consumer prices, actual costs, and the availability and costs of both competing advertising media and alternative means of transmission.

2. BNSC as a Non-Common Carrier. -- The Commission will have full regulatory power over BNSC as a non-common carrier, just as it will over the proposed corporation as a common carrier. Perhaps the most useful approach is to consider BNSC as a joint venture akin to the non-profit cooperatives currently licensed by the Commission.

In order to form a cooperative, prospective members must be licensed by the Commission.* It can condition a license on conformity with a variety of standards. The BNSC charter will specify the basis on which charges to commercial users will be determined, its revenues distributed, and its policies developed. In considering the initial license application, the Commission will have full opportunity to scrutinize the charter and the financial, technical,

*Normally, communications cooperatives are relatively small organizations. There is usually no need, therefore, for exhaustive Commission examination of their operations. Moreover, as non-profit organizations their revenues cannot exceed their costs and the Commission need only ensure compliance with this standard in reviewing their rates.

and other details of the proposed arrangements. Subsequently, the Commission can exercise the complete scope of its regulatory powers in reviewing the organization's operations to ensure adherence to the terms of the license.

BNSC could, for example, be required to file full reports on its operations, and the Commission could stipulate that its license would be withdrawn for failure to meet any standards established in the original license. Regulations tailored to the particular situation would, no doubt, be needed. But the Commission has a sound precedent for developing procedures in the Regulations issued as Appendix A to In the Matter of Amendment of the Commission's rules to permit expanded cooperative sharing of Operational Fixed stations, F.C.C. Docket No. 16218 (1966). Of particular importance, since there is no statutory requirement that cooperatives' rates meet particular standards, the Commission would have great flexibility in examining the policies involved in establishing the rates charged commercial broadcasters and the treatment accorded non-commercial television.

Beyond this, BNSC will be a consensual undertaking by commercial and non-commercial broadcasters. All aspects of the organization and its operations will be openly arrived at on a basis of full agreement among the parties. Inherently, therefore, substantial safeguards for the protection of all concerned will be built into the organization's structure.

Under the present Commission rules participants in a cooperative may use its facilities only on a cost-sharing, non-profit basis. See generally

Appendix A of In The Matter of Amendment of the Commission's rules to permit expanded cooperative sharing of Operational Fixed stations, supra.

The two basic purposes for requiring cooperatives to charge rates on a non-profit, cost-sharing basis, however, are not applicable to BNSC. The first purpose is to protect members from being charged rates based on value of service. Such rates normally put certain members at a competitive disadvantage. No such problem arises if all commercial members of a cooperative voluntarily pay a higher rate than non-commercial members.

The second purpose of the non-profit rates requirement is to prevent cooperatives from becoming profit-making, quasi-common carriers, not subject to adequate Commission regulation. BNSC will, however, be subject to full Commission regulation and will earn no profit from the rates charged commercial broadcasters.

We believe, therefore, that the Commission will have ample opportunity to exercise its jurisdiction over BNSC in all ways that it determines advisable.

Respectfully submitted,

The Ford Foundation

by McGeorge Bundy
McGeorge Bundy, President

Ginsburg and Feldman
Attorneys for the Ford Foundation

David Ginsburg
David Ginsburg

Lee R. Marks
Lee R. Marks

Thomas Ehrlich
Thomas Ehrlich,
Stanford, California
Of Counsel

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In the Matter of the

Establishment of domestic communications
satellite facilities by non-governmental
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No. 16495

TECHNICAL AND ECONOMIC DATA

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4(c)(4), AND 4(d) OF THE COMMISSION'S NOTICE OF
INQUIRY OF MARCH 2, 1966, AND PARAGRAPHS 3(a),
3(c)(2), 3(c)(3), AND 4 OF THE SUPPLEMENTAL NOTICE
OF INQUIRY OF OCTOBER 20, 1966.

December 12, 1966

The Ford Foundation
New York, New York

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The Ford Foundation
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VOLUME III

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PART I

HOW THE NETWORKS AND THE COMMON CARRIERS OPERATE TODAY IN THE TRANSMISSION OF TELEVISION AND RADIO SIGNALS

Section A. Operations as Seen by the Supplier

Network operations are a specialized service of AT&T. To satisfy the users of this service, AT&T must meet the following requirements:

- (i) The quality of transmission as measured by the ratio of signal to noise and the signal distortion must be suited to the particular needs of the user.
- (ii) The service must be highly reliable; this requires duplicative facilities which can be rapidly interchanged with a minimum of lost time.
- (iii) The system must be flexible to adjust to the normal variations in channel requirements (daily, weekly, and seasonal), as well as to occasional peak requirements associated with important news events.

The AT&T Long Lines Department conducts business with the networks, proposes rates and regulations for this service, files these with governmental agencies, and plans and constructs network facilities. It shares operating responsibility with the associated operating companies in each geographic area.

Each of the commercial networks has a set of interconnected routes that remains stable over time, subject, of course, to day-to-day temporary changes.

AT&T receives an average of 300 change requests a day for routine network operations. Special or recurring events, such as football games, require still farther changes and interconnections, often on short notice. An event such as the Pope's visit to New York may also create a demand for new and temporary services at points not lying on existing routes. The peak demand for route changes may, as in the case of President Kennedy's assassination, reach as many as 1200 a day.

The basic functions performed by AT&T in network operations are testing communications links and interconnecting them in order to meet demands for route changes and additions. These functions are largely performed in one or more of the 110 Television Operating Centers (TOC) in the United States. At the New York TOC, which serves as the main control point for most network operations, requests by the networks for route changes are converted into requirements for specific equipment, facilities, and interconnections. Orders are then issued to other TOC's for detailed scheduling of changes, and the testing and alignment of channels.

Peaks in switching loads frequently occur on fall weekends when the networks televise major football games. During any break in the game, each national network may be segmented into as many as 16 or 20 regional

networks to provide for local advertising and then reconnected in minutes on oral cue or on a prescheduled basis.

Section b. Operations as Seen by the Users

Although each network differs in internal operations and in geographic routing of programs to its affiliates, a description of one can provide an overview of routine practices and problems. Using as an example a summer-time NBC television program originating in New York, the distribution process is approximately as follows: The program is first fed to the eastern "A" network which normally serves all stations in New England, New York, Pennsylvania, West Virginia, and part of Ohio. The same program is repeated from New York one hour later on the "B" network which serves stations in the balance of the country except for the Pacific Coast states. One leg of the "B" network extends west to Los Angeles, where the programs are normally recorded as received and released two hours later at the proper clock time on the Pacific Coast network. During summer months, therefore, programs are transmitted at three different times. (Mountain Time Zone viewers cannot see programs at the same clock time as other zones.) When Daylight Saving Time ends, the "A" and "B" networks merge into a single network with a single feed originating in New York; the only delayed broadcasts are for the Pacific Coast network, three hours later.

If an advertiser wishes to reach a limited geographic area, regional commercials can be inserted at key stations along the network. Flexibility in selling specific markets within a region is now limited by the networks' routes.

AT&T charges to the networks for their normal route interconnections are governed by FCC Tariff 240. A typical rate under this tariff is \$57 per mile per month, based on a 16-hour day, excluding terminal charges. The costs for these facilities are allocated among the affiliated stations being served. An affiliate in an isolated market has to pay relatively higher charges for obtaining network service because it has no other stations with which to share the costs. Many such affiliates have installed their own inter-city microwave facilities to obtain network service from another affiliate. Some of the smaller affiliates have not installed complete microwave systems but rely on "off-air-pickups." The quality of these pickups is generally inferior, particularly for color broadcasts.

In many cases, broadcasters have formed cooperative enterprises to obtain television network service via their own microwave systems. One of the more elaborate systems is the Skyline Television Network, which distributes the programs of all three national networks to eight television stations in Idaho, Montana, and western Wyoming. This system includes approximately 1500 channel-miles of television microwave facilities, none of which is owned or operated by AT&T. See Volume 1, Part 2, for a discussion of the background and economics of this system.

Channels are needed not only for program distribution but also for assembling programs that originate in several places (e. g., a news program). For such program assembly, it is universal practice to bring all distant feeds

to a single location, usually New York or Los Angeles, so that all switching functions are under the immediate control of the program director. Channels for program assembly are kept separate from channels required for program distribution, and are ordered only as needed and generally on short notice. When live programs do not originate in studios (e. g. , sports broadcasts from stadiums), considerable advance notice may be needed by AT&T to permit installation and check-out of equipment.

Section C. Standards of Performance

There is no single authority for determining performance standards for transmitting TV signals. Standards are published by the CCIR, National Association of Broadcasters, Electronics Industries Association, and others. The performance criteria used by AT&T are summarized below.

General Performance Criteria for Color TV Service in the United States

	Voltage peak-to-peak vs. Noise rms. (db)	Differential Gain* (db)	Differential Phase* (degrees)
End-links, single segments, and local loops	67.0	0.7	1.5
Cross-country network feeds from TOC to TOC	55.0	1.0	2.0
Overall network objectives	53.0	±2.0	±2.0

- * For overall objectives, the worst case combination should rate "just perceptible" in terms of TASO/FCC subjective quality of random noise; otherwise the criteria relate to standard deviations.

Source: Bell System Practice, Section 215-015-100, Issue 3 (Television Signal Analysis).
Transmission Systems for Communications, 3rd Ed., BTL Staff, Chapter 16, page 388.
Performance of Bell System Intercity Nets Transmitting NTSC Color TV Signals, A. D. Fowler, BTL, 1966, IEEE Convention Record.

Specific standards have not been published for non-commercial or ITV service, but common carriers are permitted to offer a lower quality service at lower rates.

Signals are monitored for quality in the TOC's and in certain stations affiliated with each commercial TV network. Since monitoring involves both precise measurement and subjective evaluation, there are occasional disagreements over quality. These disagreements are resolved between the networks and AT&T, and a rebate is made if AT&T is at fault. AT&T gives no performance guarantees, and is not subject to penalty payments if signal standards are not met.

AT&T meets reliability requirements by providing one back-up circuit for every five active circuits. These can be rapidly interchanged so as to minimize outage time. Signals of reasonable quality are thus available in excess of 99.9 percent of the time. The networks in turn are responsible to the advertising agencies for outages or poor signals. When these occur, the agencies are permitted to advertise at another time without charge.

PART 2

A TECHNICAL DESCRIPTION OF REPRESENTATIVE SYSTEMS: BNS-3 AND BNS-4

The Foundation outlined two possible satellite configurations in its August 1 Submission -- BNS-1 and BNS-2. Thereafter, the Foundation consulted with the networks, the common carriers, and Comsat, and asked the Hughes Aircraft Company and the Philco-Ford Corporation to prepare preliminary systems analyses as bases for improvements in the BNS configurations. The results are here presented in two modified BNS models, designated BNS-3 and BNS-4. These have been designed by Dr. Harold A. Rosen of Hughes, on leave for this purpose to the Ford Foundation.

BNS-3 consists of two satellites in synchronous orbit; BNS-4 has three satellites in orbit. The system comprises satellites, earth terminals, the operations control centers, and the short links (as required) between earth terminals and broadcasting stations. Compared with their August 1 counterparts, BNS-3 and BNS-4 provide improved service in that they bring into the system Alaska, Hawaii, Puerto Rico and the Virgin Islands, are more reliable, make more efficient use of the frequency spectrum, and are more flexible.

Description of Technical Characteristics of BNS-3 and BNS-4

by Harold A. Rosen *

A. Space Segment

BNS-3 and BNS-4 each use 24-channel satellites, designed for the Atlas-Uprated Agena or Titan 3B-Agena boosters. The satellite uses the Atlas-Uprated Agena capability fully and thus achieves the best ratio of payload to cost. Large satellites permit more efficient use of the frequency spectrum and of positions along the synchronous equatorial orbit. BNS-3 uses two satellites in orbit, BNS-4 uses three. Spacing between adjacent satellites is 2 degrees.

The satellite is of the basic spin-stabilized, pulse-jet controlled configuration used in the Syncom and Early Bird satellites. It is designed for an operational life of ten years.** The major subsystems are the antenna system, the microwave repeaters, the control system, the power system, the telemetry and command system, and the structure. Figure 2.1 is a sketch of the BNS satellite.

The antenna system consists of a single reflector and multiple feed horns. The reflector is a section of a parabolic surface, 9 feet wide and

* Dr. Harold A. Rosen, Assistant Manager of Space Systems Division, Hughes Aircraft Co., is a leading communications satellite designer. He was Technical Director of the Syncom Project, and received the 1964 Astronautics Engineer Award from the National Space Club.

** The satellites have been depreciated over five years even though designed for ten years.

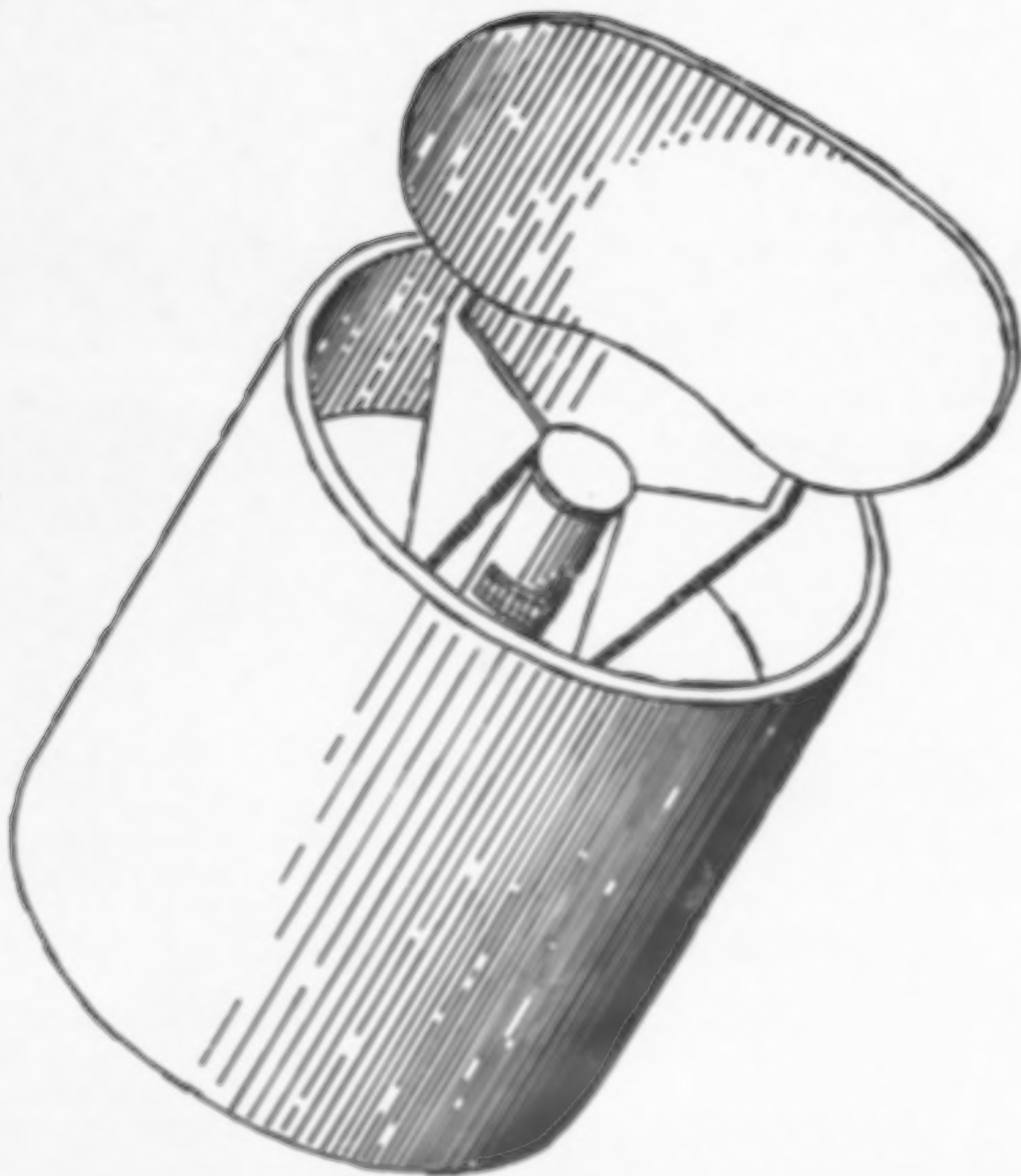


Figure 2.1 BNS Satellite

6 feet high, illuminated by seven offset horns. Four of these horns form adjacent beams of width 3.5 degrees by 2.2 degrees, corresponding in coverage to the four time zones of the 48 contiguous states. The beam centers of these horns are squinted north 6 degrees for optimum coverage of this area, and their feeds have dual linear polarization terminals for both transmitting and receiving frequencies. The fifth and sixth horns form beams which are directed at the states of Alaska and Hawaii, respectively, and the seventh horn forms a beam directed at Puerto Rico and the Virgin Islands. The areas covered by the beams are shown in Figure 2.2, and the corresponding squint angles required in the satellite are listed in Table 2.1. The receiving terminals of the horns are connected to low-noise tunnel diode preamplifiers, followed by the input switches and diplexers of the microwave repeaters.

Twenty-four microwave repeaters are provided, each capable of relaying to earth terminals one high-quality color television channel plus switching instructions. Each repeater has a tunnel-diode amplifier operating in the 6 Gc/s band, a down-converter, a tunnel-diode amplifier-limiter, and a 5-watt output traveling wave tube operating in the 4 Gc/s band. The bandwidth of each repeater is 40.0 Mc/s and the center frequencies are separated by 41.67 Mc/s. The 500 Mc/s bandwidths allocated in the 6 Gc/s and 4 Gc/s bands are each used twice by the satellite by employing a combination of polarization and beam angle diversity.

As many as six channels may be simultaneously directed to each of the four time zones of the contiguous states. However, two of the Mountain Time

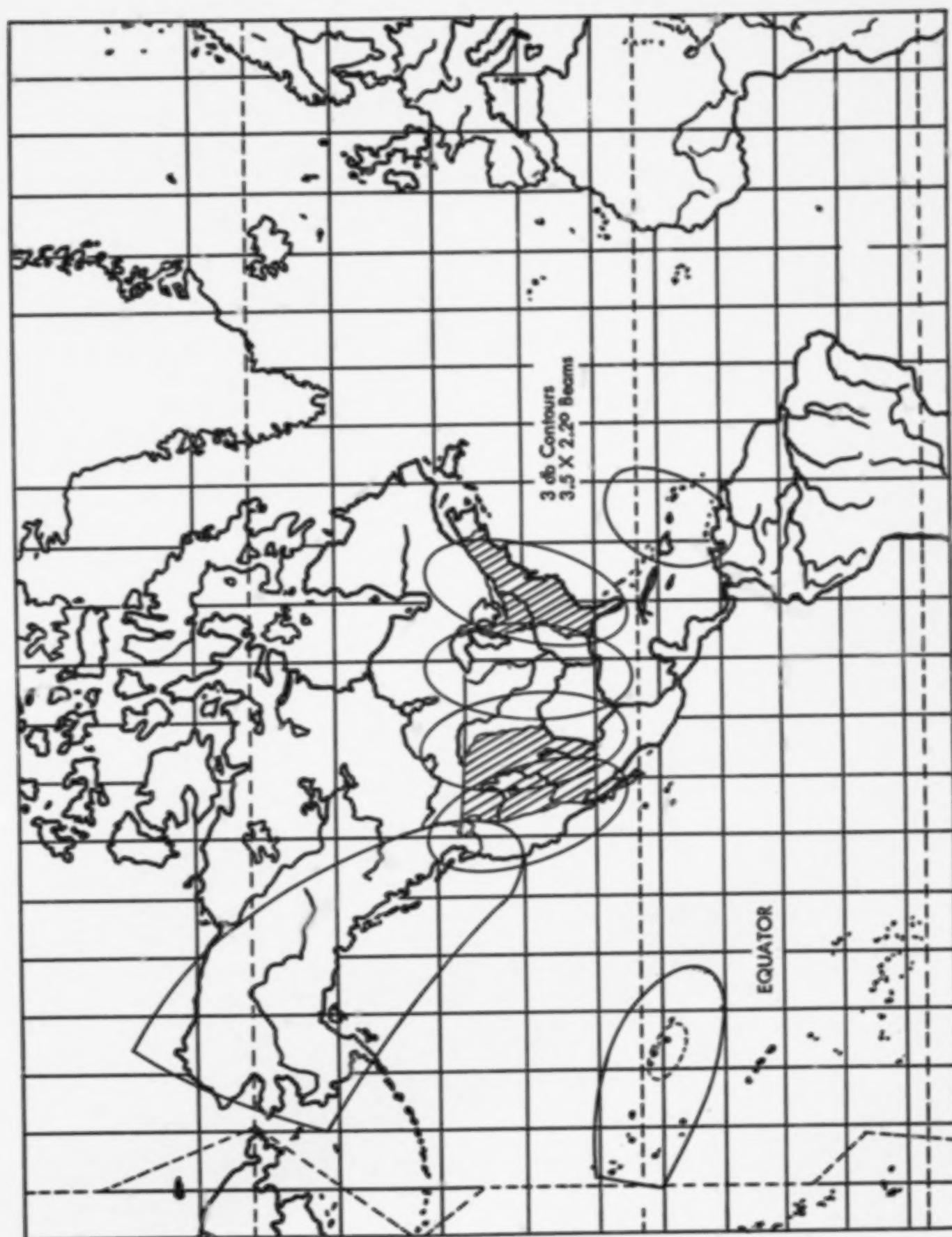


Figure 2.2 Area of Coverage of BNS System

Table 2.1 Desired Pointing Angles and Antenna Gain

	Beams from Satellite at 97° W. Longitude						
	Hawaii	Alaska	Pacific	Mountain	Central	Eastern	Puerto Rico
Elevation (degrees)*	3.2	8.0	5.9	5.9	5.9	5.9	3.0
Azimuth (degrees)*	-7.5	-3.2	-2.4	-0.8	0.8	2.4	4.8
Beamwidth Assumed for off-Axis Allowance Below	minimum feasible	minimum feasible	3.5° North-South		2.2° East-West		minimum feasible
Gain on Axis (db)	34.5	36.0	36.0	36.0	36.0	36.0	34.5
Off-Axis and Range Allowance (db)	-0.5	-2.0	-2.0	-2.0	-2.0	-2.0	-0.5
Net Gain For Links (db)	34.0	34.0	34.0	34.0	34.0	34.0	34.0

* Angles relative to nadir

Zone channels may be switched to feed Alaska and Hawaii, and one of the Central Time Zone channels may be switched to feed Puerto Rico and the Virgin Islands. Signals originating in Alaska, Hawaii, Puerto Rico or the Virgin Islands are received in channels whose receivers are switched from the use for the contiguous states. Additional detail concerning the use of the repeaters is contained in the discussion of operational considerations below.

Orbit and orientation control are provided by two independent control systems, each containing an axial and a radial jet, diametrically opposed fuel tanks, and 120 pounds of hydrazine fuel. The control system is capable of correcting the initial orbit injection errors, acquiring the designated equatorial station near 97 degrees West Longitude, and maintaining orbital station to within 0.05 degrees and orientation to within 0.2 degrees for 10 years.

The power system consists of a cylindrical array of solar cells, 9 feet in diameter and 8 feet high. It will deliver 600 watts of power during the least favorable time of year, after 10 years of degradation in orbit. Energy storage is supplied by the nickel-cadmium batteries, adequate to power 12 of the repeaters during the infrequent eclipses (less than 1 percent of the time, around local midnight).

The telemetry and command system operates on the microwave bands, as in Early Bird. Command functions are required to actuate the jets for orbit and orientation control, fire the apogee motor, control the microwave repeaters, and aim the antenna. The telemetry system reports the state of the satellite and confirms commands prior to execution.

The simple cylindrical structure characteristic of present spin-stabilized stationary satellites has been retained. The new satellite is larger than previous models, however, and its mechanically despun antenna system imposes new structural requirements. Nonetheless it is possible to hold the weight of the antenna structure to less than 10 percent of the payload weight.

The weight budget for the payload given in Table 2.2 is based on the use of an SLV-3C Atlas-Uprated Agena boost vehicle with an OAO fairing. The apogee engine is a Surveyor Retro TE-364-3 having a propellant loading of 1062 pounds. The booster can inject a payload well in excess of 2300 pounds into a synchronous altitude transfer orbit apogee inclined 28.7 degrees with the equatorial plane. A detailed weight budget for the spacecraft is given in Table 2.3.

B. Earth Segment

BNS-3 and BNS-4 will each have 233 earth terminals, of which 223 will be fixed and 10 will be mobile. It will also have a number of communication links connecting these terminals to the broadcast stations and the ITV facilities, and two operations control centers performing the switching and testing functions of network operations. Services for maintaining the satellites on station will be purchased.

There are four kinds of earth terminals: First, network terminals in four major metropolitan areas that can transmit simultaneously on 21 channels

Table 2.2 Weight Budget for Boost Vehicle Payload

Item	Weight (in lbs.)
Boost Vehicle Payload Weight	2300
Agena Adaptor	50
N ₂ Spin-up gas	10
Apogee Ignition Weight	2240
Engine Propellant	1062
Engine Expendable Inerts	16
Injected Weight	1162
Apogee Engine Case	114
Apogee Engine Adaptor	38
Initial Orbit Condition of Spacecraft	1010
N ₂ H ₄ Propellant	240
Final Orbit Condition of Spacecraft	770

Table 2.3 Weight Budget for Spacecraft

Item	Weight (in lbs.)
Antenna	70
Reflector	60
Feeds	10
Electronics (Despun)	154
TWTs, Power Supplies	66
Receivers, T-D amplifiers	78
Diplexers	4
Switches, Coax, etc.	6
Electronics (Spinning)	54
Telemetry and Command	42
Telemetry Transmitters	1.5
Whip Antennas	1.5
MACE	9
Harness	18
Power Supply	200
Solar Panels	150
Batteries	50
Reaction Control System	65
N ₂ H ₄ -- Dry	46
N ₂ (spin-up) -- Dry	19
Structure	181
Basic	99
Despin Bearing Assembly	50
Despun Platform	32
Miscellaneous	20
Contingency	8
Final Orbit Condition of Spacecraft	770

(7 in each satellite), or receive simultaneously on any of 18 channels (6 in each satellite); second, 173 affiliate terminals that can receive simultaneously on 6 channels; third, 46 affiliate terminals that can transmit simultaneously on 3 channels or receive simultaneously on 6; and, fourth, 10 mobile terminals that can transmit 1 video channel and receive voice instructions.

These terminals provide TV coverage for most of the population of the United States, including Alaska, Hawaii, Puerto Rico and the Virgin Islands. Since each fixed terminal can be shared by all nearby users, it provides the capability for ITV service as well as for commercial and non-commercial service. The amount of ITV used will depend on local and/or state educational authorities. Students not residing near these 223 fixed terminals can be served by the BNS satellites through "remote schoolhouse" terminals of smaller and less costly design.

The characteristics of the various types of earth terminals are summarized in Table 2.4. The expected signal and noise powers for the video links in the system are then given in Table 2.5. Our analyses confirm that in all cases the delivered picture quality is better than AT&T standards and even exceeds the standards recommended by CCIR for monochrome transmission. The expected system performance will permit more than one hop through the satellite while still meeting video performance standards. Since the down-link carrier-to-noise ratios shown are considerably in excess of the usual 10 db discriminator threshold, the corresponding rain margins are therefore more than adequate.

Table 2.4 Characteristics of Earth Terminals

	Type of Earth Terminal			
	Network	Affiliate		Mobile
		Type I	Type II	
Number	4	46	173	10
TV Channels				
Receive	18	6	6	0
Transmit	21	3	0	1
Receiver				
Noise Temperature (degrees K)	80	160	160	160
G/T (db)	31	25	25	20.5
Antenna				
Type		CASSEGRAIN		
Diameter (feet)	35	25	25	15
Feeds	3	3	3	1
Transmitter				
RF Power per channel (watts)	100	50	-	50
ERP per channel (dbw)	73	67	-	63

Table 2.5 Signal and Noise Power Levels for Video Links

	Network Terminal	Affiliate Terminal (with transmitting capability)
Up-Link:		
Earth station power	20 dbw	17 dbw
Earth station antenna gain	53 db	50 db
Propagation loss	-200 db	-200 db
Satellite receive antenna gain	36 db	36 db
Off beam center loss	- 2 db	- 2 db
Satellite received power	- 93 dbw	- 99 dbw
Satellite receive noise	-124 dbw	-124 dbw
Carrier/Noise in satellite	31 db	25 db

Down-Link:		
Satellite channel power	7 dbw	7 dbw
Loss	- 1 db	- 1 db
Antenna gain	36 db	36 db
Off beam center loss	- 2 db	- 2 db
Propagation loss	-196 db	-196 db
Earth station antenna gain	50 db	47 db
Earth station received power	-106 dbw	-109 dbw
Noise power in receive bandwidth	-133.6 dbw	-130.6 dbw
Carrier/Noise ratio in receiver	27.6 db	21.6 db
Up-link noise contribution	1.6 db	1.6 db
Carrier/total noise ratio	26 db	20 db
FM Improvement Factor	22 db	22 db
Peak-peak picture/rms video factor	6 db	6 db
Pre-emphasis and noise weight	13 db	13 db
Peak-peak picture/rms noise	67 db	61 db
Margin above CCIR objective	11 db	5 db

C. Operational Considerations

The channels are so arranged that half of the total channels are accessible on the up-link from each of the time zones in the contiguous states. The remaining channels become accessible by relaying through one of the network terminals. The parameters of the terminals have been selected to permit relaying with only about 1 db degradation of the signals as compared with a single hop. Programs originating in Alaska, Hawaii, Puerto Rico, and the Virgin Islands will generally require relaying.

Of the 48 channels provided by BNS-3, 24 are for commercial network distribution and constitute the priority demand on the system. The remaining 24 channels serve non-commercial and instructional needs, and provide the back-up for meeting peak commercial loads. Of the 72 channels provided by BNS-4, 28 are for commercial network distribution and constitute the priority demand on the system. The remaining 44 channels serve non-commercial and instructional needs, and provide the back-up for meeting peak commercial loads. For additional details regarding the uses of channels, see Part 3 of this volume.

In the terrestrial distribution system, it is customary to use back-up or "protection" channels to handle peak loads, and the same practice will be followed in the BNS system. Peak loads normally occur during breaks for advertising on football weekends. Since these peaks do not coincide with instructional television peak requirements, a large number of channels are available to be assigned simultaneously to one network by BNS. The operations

control center then sends appropriate switching instructions to the affiliate stations via order wire channels carried by the satellite repeaters. These instructions automatically preset the tunable receivers to the appropriate channels; on cue, the regional commercial signals received by the affiliates are automatically switched on the air.

The up-link and down-link channel assignments for all areas covered by the BNS system are illustrated in Table 2.6. The Pacific and Mountain Time Zones have up-link access on the odd-numbered channels with horizontal polarization (H), and on the even-numbered channels with vertical polarization (V). Channel 1 with horizontal polarization could thus be assigned to either the Pacific or Mountain Time Zone on the up-link. The Central and Eastern Time Zones have up-link access on the same channels but with opposite senses of polarization. Adjacent satellites would have reversed senses of polarization for discrimination from the ground, in addition to their physical separation.

As seen from Table 2.6, for example, transmissions from the Pacific Time Zone can be repeated throughout the Pacific Time Zone on channels 1, 5 and 9; throughout the Mountain Time Zone on channels 2, 6 and 10; throughout the Central Time Zone on channels 3, 7 and 11; and throughout the Eastern Time Zone on channels 4, 8 and 12.

The channels for Alaska, Hawaii, Puerto Rico and the Virgin Islands are time-shared with the above channel-zone assignments and are switched into service as required by the operations control center of the BNS system.

Table 2.6 Channel - Zone Assignments

			Up Link Channel - Zone Assignments													
			Hawaii		Alaska		Pacific		Mountain		Central		Eastern		Puerto Rico	
			H	V	H	V	H	V	H	V	H	V	H	V	H	V
Down Link Channel - Zone Assignments			Hawaii		Alaska		Pacific		Mountain		Central		Eastern		Puerto Rico	
			H	V	H	V	H	V	H	V	H	V	H	V	H	V
				6				6		6						

Notes: V = Vertical Polarization
H = Horizontal Polarization

PART 3

COSTS AND REVENUES OF BNS-3 AND BNS-4

Section a. System Costs

We contemplate that initially two satellites will be placed and maintained in orbit. The cost for this configuration, BNS-3, is shown in Table 3.1; initial capital cost is \$101.3 million and level annual cost \$28.8 million. As demand for satellite channels grows, a third satellite would be placed and maintained in orbit. The cost of this expanded system, BNS-4, is shown in Table 3.2; initial capital cost is \$115.8 million and level annual cost \$31.8 million.

The system cost for each configuration includes the cost of design engineering, hardware procurement, facilities, initial training of personnel, initial spares and installation of equipment at each terminal or location as well as the cost of over-all program management. The annual operations cost (including maintenance) includes the cost of operating all terminals, the short communication links, and the operations control centers.

TABLE 3.1

**BROADCASTERS' NON-PROFIT SATELLITE SYSTEM:
A NEAR-TERM CONFIGURATION (BNS-3)**

TABLE 3.1

**BROADCASTERS' NON-PROFIT SATELLITE SYSTEM:
A NEAR-TERM CONFIGURATION (BNS-3)**

<u>Total channel capacity</u>	48
<u>Services provided (in channels)</u>	
Commercial	24 (priority demand)
Non-commercial	4
Instructional:	
Primary-secondary schools	12
Colleges and universities	4
	44 (plus 4 in reserve)
<u>System components</u>	
Satellites	2, each with a capacity of 24 channels of color TV
Earth Terminals:	
Network	4, each capable of receiving on 18 channels and transmitting on 21. Each terminal has a 35-foot antenna.
Affiliate	219, each capable of receiving on 6 channels. Of these, 46 are also capable of transmitting on 3 channels. Each terminal has a 25-foot antenna.
Mobile	10, each capable of transmitting on 1 channel and receiving voice instructions. Each terminal has a 15-foot antenna.
Communication Links	connecting earth terminals to broadcasting stations and ITV facilities.
Operations Control Centers	2, each capable of providing the switching and testing functions for network operations.
This system can accommodate remote schoolhouse terminals; costs of such terminals are not included in our estimates.	

BROADCASTERS' NON-PROFIT SATELLITE SYSTEM (BNS-3)

<u>Initial Capital Cost</u>		<u>Millions of Dollars</u>
System R & D ^{1/}		\$ 20.0
Space Segment ^{2/}		29.0
Earth Segment		52.3
Terminals	\$39.6	
Other	12.7	
		<u>\$ 101.3</u>

<u>Level Annual Cost</u>	<u>Millions of Dollars</u>
Depreciation and Interest ^{3/}	\$ 17.8
Operations (including maintenance) ^{4/}	11.0
	<u>\$ 28.8</u>

Notes

^{1/} This is more conservative than the two estimates given to the Foundation by the satellite manufacturers who were consulted. Their estimates were \$15 million, and \$18.8 million.

^{2/} The space segment consists of two satellites. Three additional launches will be required over the first 10 years of operation.

^{3/} Satellites, including the three additional launches, are depreciated over five years. The earth segment is depreciated over 10 years. A six per cent interest rate on the undepreciated balance is assumed.

^{4/} This includes the initial cost of starting a new organization, including recruitment cost.

TABLE 3.2

BROADCASTERS' NON-PROFIT SATELLITE SYSTEM:

AN EXPANDED CONFIGURATION (BNS-4)

TABLE 3.2

**BROADCASTERS' NON-PROFIT SATELLITE SYSTEM:
AN EXPANDED CONFIGURATION (BNS-4)**

<u>Total channel capacity</u>	72
<u>Services provided (in channels)</u>	
Commercial	28 (priority demand)
Non-commercial	4
Instructional:	
Primary-secondary schools	28
Colleges and universities	4
	64 (plus 8 in reserve)
<u>System components</u>	
Satellites	3, each with a capacity for 24 channels of color TV.
Earth Terminals:	
Network	4, each capable of receiving on 18 channels and transmitting on 21. Each terminal has a 35-foot antenna.
Affiliate	219, each capable of receiving on 6 channels. Of these 46 are also capable of transmitting on 3 channels. Each terminal has a 25-foot antenna.
Mobile	10, each capable of transmitting on 1 channel and receiving voice instructions. Each terminal has a 15-foot antenna.
Communication Links	connecting earth terminals to broadcasting stations and ITV facilities.
Operations Control Centers	2, each capable of providing the switching and testing functions for network operations.
This system can accommodate remote schoolhouse terminals; costs of such terminals are not included in our estimates.	

BROADCASTERS' NON-PROFIT SATELLITE SYSTEM (BNS-4)

<u>Initial Capital Cost</u>		<u>Millions of Dollars</u>
System R & D ^{1/}		\$ 20.0
Space Segment ^{2/}		43.5
Earth Segment		52.3
Terminals	\$39.6	
Other	12.7	
		<u>\$ 115.8</u>

<u>Level Annual Cost</u>	<u>Millions of Dollars</u>
Depreciation and Interest ^{3/}	\$ 20.8
Operations (including maintenance) ^{4/}	<u>11.0</u>
	\$ 31.8

Notes

^{1/} This is more conservative than the two estimates given to the Foundation by the satellite manufacturers who were consulted. Their estimates were \$15 million, and \$18.8 million.

^{2/} The space segment consists of three satellites. Four additional launches will be required over the first 10 years of operation.

^{3/} Satellites, including the four additional launches, are depreciated over five years. The earth segment is depreciated over 10 years. A six per cent interest rate on the undepreciated balance is assumed.

^{4/} This includes the initial cost of starting a new organization, including recruitment cost.

Section b. System Revenues

The Foundation's proposal assumes that the commercial networks and other interested parties will together determine equitable pricing formulae. The clear goal is to obtain revenues sufficient to cover level annual costs (\$28.8 million for BNS-3) and generate funds for non-commercial television programming. The sums that can be generated for programming lie somewhere between the costs of a BNS system and the present costs of terrestrial facilities.

Although we believe the three commercial networks will provide the bulk of the system's revenues, they are by no means the only sources of revenue. A fourth network -- the Overmyer Network -- is expected to begin operations in April 1967 with about 125 affiliates. Revenues from this network may in time approach the revenues derived from each of the existing networks.

In addition to existing network services, BNS may generate additional revenues from the commercial networks. For example, the commercial networks have no interconnections with Alaska or Hawaii; these would be economical and practical with satellites. Some affiliated stations now operating microwave links or off-air pickups because of the high cost of AT&T facilities might revert to network interconnections with the satellite system.

Federal and state governments and private industry would probably use the BNS system for television distribution of in-service training and similar educational programs. The Department of Labor, for example, might well use

the BNS system in its manpower training programs. The Office of Economic Opportunity has already had experience with television as a training medium in Job Corps camps. The Department of Defense has already used television for training electronics specialists; the potential for many other armed service educational programs is apparent. Finally, large industrial enterprises have constant need to train salesmen and field engineers throughout the country in the characteristics of new equipment. These needs can all be met through BNS, and should produce revenues for the system.

Whether to charge school authorities for channels for instructional television raises difficult and perplexing questions. A primary goal of the Foundation's proposal is to make available facilities for a dramatically expanded use of instructional television. In the past, a primary obstacle has been high program distribution costs. At the minimum, instructional television must be offered channels at greatly reduced rates. A strong argument, in terms of social purpose, can be made for offering instructional television channels free of cost. If the pricing mechanism is abandoned, however, there may be troublesome problems in allocating instructional television channels.

Section c. Demand Forecast

At the April 1966 meeting sponsored by Comsat, NBC presented a study which it had commissioned from the Astro-Electronics Division of RCA. NBC specified that the system should be able to distribute 3 different programs simultaneously for each network, with a service reliability of 99.93 percent. These 9 channels together with 3 to be used by a fourth network represented the priority demand of all the commercial networks.

To obtain additional background on the potential demand for satellite use by instructional and non-commercial broadcasters the Foundation commissioned a study from the firm of Hammett and Edison, Consulting Radio Engineers, San Francisco, California. Whereas Hammett and Edison projected for the decade 1970-80 about a 30% growth in satellite use by commercial broadcasters, they projected about a 300% growth for non-commercial broadcasting and instructional television for the same period. Hammett and Edison also concluded that by the end of the first decade commercial requirements might represent only about half of the total demand for channels.

These projections were based on the assumption that a non-commercial network will expand its coverage gradually throughout the decade, that the number of states with integrated school and university ITV systems will continue to grow, and that governmental and professional groups will increasingly turn to ITV for retraining programs. Their projection further assumes that at the end of the decade a CATV network will emerge.

The Foundation recognizes that growth in the demand for non-commercial and instructional television will not be automatic. Imaginative demonstrations of what can be done are essential. The Foundation, moreover, is aware that instructional television must overcome some resistance engendered by commonplace use of the medium in the past, and by the natural resistance of those who are unaware of the vital role that instructional television can play in supplementing the efforts of teachers and enriching the curriculum.

PART 4

ADEQUACY OF THE FREQUENCY SPECTRUM

Paragraph 4(c)(1) of the Federal Communications Commission's Notice of Inquiry of March 2 asks whether it would be in the public interest to authorize non-common carriers to construct and operate domestic communication satellite facilities considering "The amount of frequency spectrum now available for the communication satellite service under the Commission's Rules." * Paragraph 4 of the Commission's Supplemental Notice of October 20 again asks responding parties to consider the adequacy of existing allocations to the communication satellite service.

The Federal Communications Commission's inquiry must be considered in the context of mounting concern over the demands on the frequency spectrum. Referring to communication satellites, General James D. O'Connell, Director of Telecommunications Management, recently noted that unless "a lot of thought is devoted to this subject, the frequency limitations will ultimately deter the use of this capability." Telecommunication Reports (May 9, 1966). A recent report refers to the advent of communication satellites as "the clearly dominant consideration for future spectrum utilization." Electromagnetic

* The frequency band 3700 Mc/s to 4200 Mc/s for the down-link and 5925 Mc/s to 6425 Mc/s for the up-link.

Spectrum Utilization -- the Silent Crisis, a Report by the Telecommuni-
cation Science Panel of the Commerce Technical Advisory Board
(October 1966).

The Foundation's August 1 Comments replied to the Commission's inquiry with three basic points:

- Distribution of television signals will have a high priority for using communication satellites.
- The Foundation's proposal for a separate television satellite system would not impose additional demands on the frequency spectrum as compared with common carrier or Comsat distribution of the same television signals.
- The frequencies presently allocated to the communication satellite service are adequate to meet foreseeable demands in the relevant time frame.

We elaborate these comments here.

The Priority of Television Distribution

Four basic points suggest that television distribution will have a high priority over other claimants for using communication satellites.

First, the economic analysis set forth in Volume I, Part 2, and Volume III, Part 3, of this Submission indicates that enormous cost savings will be derived by transmitting television signals via satellite. The nature of television distribution -- from a limited number of points to many points without a need for privacy -- complements the inherent technical characteristics of satellite technology: the ability to irradiate

large areas and lay down a uniform signal without regard to the distance between the transmitting point and the many receiving points.

The lessened dependence of cost on distance will also benefit telephone and data transmission but not as much. The switching equipment necessary for any point-to-point communication, whether by satellite or land lines, accounts for a major part of the cost of transmitting this traffic. The satellite will thus affect only a part of the total cost of point-to-point communication. It plays a much more important role in reducing the cost of television distribution which has no comparable switching requirements.

Second, synchronous satellites cause a delay in signal transmission of roughly three-tenths of a second for each hop. This delay creates no problems for one-way transmission, such as television. It does, however, create a problem for two-way transmission of either telephone or data traffic. The problem of telephone transmission could be partially solved by using the satellite for one hop and terrestrial facilities for the return, but only at increased cost. The problem of data transmission could be solved by equipment design if the traffic were always to go by satellite. It is more costly to design around this

problem, however, if traffic goes by satellite or terrestrial facilities on a random basis.

Third, although it is possible to imagine an extraordinary range of uses for satellite technology, and a demand that may at some point exceed the spectrum presently allocated, the major domestic market for satellite technology today, and for at least the next decade, is television. Comsat estimates that television would account for nearly 70% of the capacity of a multipurpose satellite system.

Fourth, television now reaches almost every home in the country. The average viewing audience during prime time may exceed 100 million people. During a national emergency, such as the Cuban missile crisis, and for great national events such as elections, access to the people through television is essential. In Volume I, Part 5, we have discussed the potential and importance of non-commercial and instructional television. Although it may be difficult to allocate priorities among various claimants in general, it seems clear to us that television will have a high claim to the benefits of satellite technology.

Form of Organization

The second question which the Commission will wish to address is how any proposed form of organization and ownership of a domestic satellite system will affect the frequency spectrum. Needless

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Form of Organization

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proliferation of small and inefficient satellite systems will undoubtedly lead to inefficient use of the spectrum. But that does not mean that all domestic services must be controlled by one organization, or that only common carriers can efficiently use the frequency spectrum.

The basic questions are not who owns and operates a satellite system or systems but the technical characteristics of the satellite and the efficiency with which a given system is used. As the Foundation indicated in its August 1 Comments, it is now estimated, conservatively, that satellites can be placed in equatorial orbit at intervals of three degrees without interfering with each other.* On this basis, 25 satellites could be placed in a band of 72 degrees visible from Maine to California. Since the number of channels per satellite does not affect the total number of satellites, large satellites will more efficiently use the 25 positions than small satellites. We can thus understand that the Commission might be reluctant to authorize systems using, for example, 8-channel satellites. However, the satellites called for in the representative BNS systems have 24 channels, twice the number proposed by Comsat. These satellites will make the most efficient use of the equatorial orbit permitted by present technology and, hence, of the frequency spectrum.

* Dr. Harold A. Rosen and others believe that satellites can be placed at intervals as close as two degrees.

A second consideration -- whether a given system will be efficiently used -- is discussed in Volume I, Part 2. We believe that BNS-3 is efficient because the requirements of instructional television during the day will complement the requirements of commercial and non-commercial television at night and on the weekends. Moreover, the system can be used in the late hours or early morning for transmitting program materials for delayed broadcast or closed-circuit transmission.

Finally, the satellite system proposed here has been specially designed to make maximum use of the frequency spectrum by using it twice. How this is done is discussed in Part 2 of this volume. Double use of the frequency spectrum is an advantage best adapted to the distribution of television signals; it can be adapted in a multipurpose satellite only by introducing constraints that may lead to inefficient operation.

If it is in the national interest to transmit television via satellite, as we believe it is, the Foundation's proposal represents more efficient use of the frequency spectrum than would be attained by common-carrier operation of a multipurpose system. At the least, separate ownership of the television distribution satellite service imposes no added demands on the spectrum.

Demand and Capacity Over a Relevant Time Frame.

The Commission's inquiry is framed in terms of "the amount of frequency spectrum now available for satellite service under the Commission's Rules." This raises the question of the time frame within which demand for satellite services and capacity must be judged. In our view a reasonable and relevant time frame at this stage is the period over which a proposed satellite system will be amortized. If the frequencies allocated to communication satellite service are changed sooner, the system will be obsolete before investment can be written off. The space segment of the BNS systems is amortized over five years and the ground environment over 10 years. Thus, if the present allocation of the frequency spectrum is sufficient to meet demands over the next 10 years, the Commission can authorize the proposed service regardless of any increased demands that may arise later. As indicated in the Foundation's August 1 Comments, we believe that the amount of spectrum presently allocated to communication satellite service is more than adequate for television and other foreseeable demands that may be made upon it within the next decade.

We do not mean to suggest that the Commission should look only to the next 10 years in considering potential satellite demands on the frequency spectrum. The Commission may wish to plan ahead to the

year 2000 and beyond. To assure adequate spectrum for the long term, it may be desirable to conduct research to extend the usable regions into the 15 to 35 Gc/s band. We here suggest only that authorization of the Foundation's proposal to meet demands over the next decade or so will make efficient use of the spectrum during that period, leaving the Commission free to make changes thereafter without economic loss.

NOTE

The Ford Foundation arranged to have this study reviewed by John P. Hagen, Professor of Astronomy, Pennsylvania State University. Professor Hagen has advised the Foundation that he concurs in both the methodology and conclusions of the study.

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1. Summary of Results

The purpose of this study is to answer as fully as possible the questions on electromagnetic interference posed by the FCC in the Notice of Inquiry of 2 March 1966, supplemented on 21 October 1966. These questions are interpreted here in terms of potential interference between the proposed BNS system and terrestrial microwave relay services or the global commercial communication satellite system. A general discussion of the various interference paths and present recommendations on allowable levels of interference is given in Section 2. In Section 3, the relevant parameters of the BNS system and of terrestrial microwave relays are stated, and selected interference phenomena are described and quantified. The problem comes down to that of finding feasible areas for siting the BNS earth stations, i.e., areas in which potential interference levels may be kept within tolerable limits. The procedure used and results obtained in an engineering study of potential interference in a major metropolitan area is presented in Section 4. This preliminary study is based on actual microwave relay facilities within 275 miles of New York City.

The conclusions reached in this study include:

- The BNS system is technically feasible under presently recommended limits on satellite power.
- It is technically feasible and economically desirable to moderate the restrictions on spectral density to provide for increasing signal strengths for higher elevation angles of arrival, as recommended by the recent CCIR meeting in Oslo.

- Assuming the existence of limits on spectral density, such as the present limits or modified limits as suggested above, restrictions on total power density are unnecessary.
- Compatible operation between BNS and the global commercial communication satellite system can be achieved by separating the satellites in longitude to enable the required amount of interference suppression by the earth station antennas.
- The most significant interference effect in the proposed BNS system under present restrictions is that produced by common-carrier transmitters at earth station receivers via scatter paths existing during a small fraction of the time. For example, rainstorms of 30 mm/hr will produce perceptible, but not objectionable, degradation of the BNS down-link signal. Rainstorms of such severity occur less than 0.02% of the time in a representative area such as New York City.
- As shown in Figure 1.1, a number of sites in and around New York City are feasible for BNS earth stations as far as interference considerations are concerned, including several sites within a radius of one microwave link from the center of Manhattan.
- Preliminary studies indicate that other areas, e.g., Denver and Atlanta, will present much greater freedom of site selection than New York.
- Gain of some BNS earth station antennas located in a few of the largest metropolitan areas must be less than -24 db in the direction of nearby common-carrier facilities, including the effect of site shielding by excavation or other means.
- Measurements are needed of: (1) common-carrier field strengths near potential BNS sites, (2) scattering cross-sections of large aircraft for all angles of scatter, and (3) psychophysical effects of common-carrier interference with the proposed BNS down-link signal.



Figure 1.1 Areas for Consideration in Siting BNS Earth Stations

2. General Discussion of the Interference Problem

The questions on electromagnetic interference posed by the FCC Notices of Inquiry are discussed in this section in general terms. The existence of a longitude "window" is shown in which BNS satellites may be placed with minimal effect on common-carrier microwave systems.

2.1. FCC Notices of Inquiry

The specific questions in the FCC Notice of Inquiry of 2 March 1966 which are here addressed are the following:

"4(d) Is it technically feasible to accommodate the space service contemplated, in light of the requirement:

- (1) That the power flux density produced at the earth's surface in the band 3700-4200 Mc/s by emissions from a space station employing wide-deviation frequency (or phase) modulation, not exceed -149 dBW/m^2 in any 4 Kc/s band for all angles of arrival, nor a total of -130 dBW/m^2 for all angles of arrival;
- (2) That the power flux density produced at the earth's surface in the band 3700-4200 Mc/s by emissions from a space station employing other than wide-deviation frequency (or phase) modulation, not exceed -152 dBW/m^2 in any 4 Kc/s band for all angles of arrival;
- (3) That earth stations receiving signals from space stations in the band 3700-4200 Mc/s be so located with respect to the existing common-carrier microwave complex in that band that they are not subjected to harmful interference from such terrestrial microwave systems;

- (4) That transmitting earth stations in the band 5925-6425 Mc/s:
 - (a) Not exceed a mean effective radiated power of 45 dbW in any 4 Kc/s band in the horizontal plane; and
 - (b) Not cause harmful interference to the existing common carrier microwave complex in the same band."

As seen in Figure 2.1, questions 4d(1) and 4d(2) relate to the interference from the down-link feeding into the terrestrial microwave networks; question 4d(3), interference from the microwave network into the broadcast stations; question 4d(4), interference from the up-link into the microwave network. Since the representative BNS systems discussed earlier are based on wide-deviation frequency modulation, question 4d(2) is not applicable.

The specific questions addressed here that were stated by the FCC in the Supplemental Notice of Inquiry dated 21 October 1966 are as follows.

"4. For the most part, comments filed thus far have not been fully responsive to the technical questions raised in the first Notice of Inquiry as to the adequacy of existing allocations to the communication satellite service or as to the electromagnetic interference to and from both present and projected operations of the global commercial communication satellite system and the domestic fixed public services sharing the same frequency bands. The latter question is complicated further by the fact that the plenary assembly of the CCIR (Oslo, June 1966), has recommended changes in the technical criteria applicable to the power flux density delivered at the earth's surface from space stations. Therefore, pending resolution of the legal status of the Oslo criteria vis-a-vis those criteria now in the International Radio Regulations, interested parties, in responding to the questions raised in our prior notice and

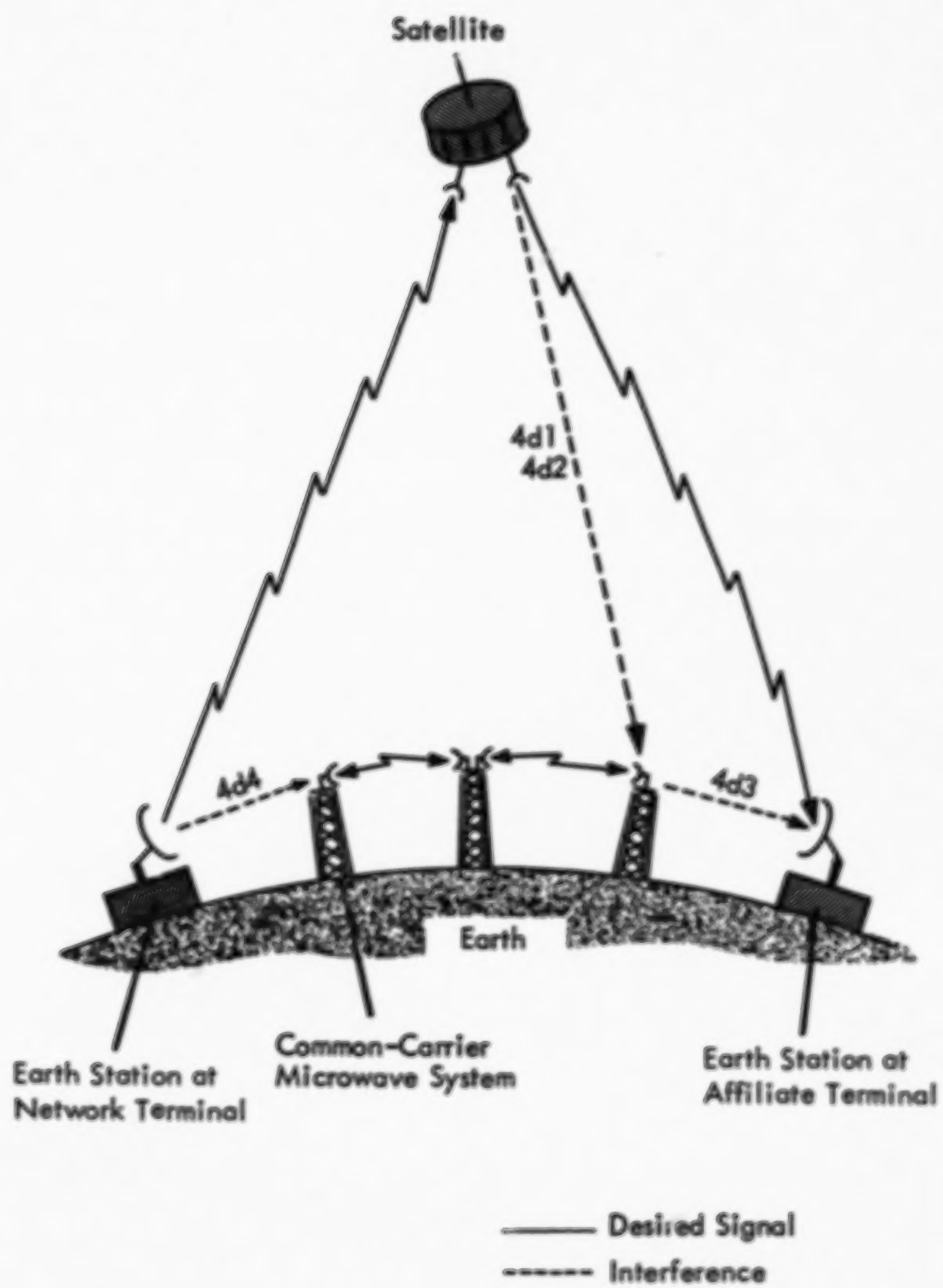


Figure 2.1 Types of Possible Radio Interference

herein (which include the technical questions explicitly set out in our prior notice), should direct their responses to both the present and Oslo criteria. Additionally, to permit an evaluation of the impact from proposed systems, parties should indicate as fully as they now can the planned positioning of space stations on the equator for the system under consideration if equatorial stationary satellites are involved."

2.2 Restrictions on Satellite ERP

Distribution of TV programs via satellite is classified under the communications-satellite service which shares most of its allocated spectrum with various terrestrial services (ITU 1963). The most important bands involved in such shared allocations at the present time relate to common-carrier microwave relays, as shown in Figure 2.2. Sharing of common bands requires that each service follow some form of restriction on effective radiated power (ERP).

The restrictions on total flux density and on spectral density given in the FCC Notice of Inquiry were recommended by the Comité Consultatif International Radio (CCIR). Figure 2.3 illustrates the limitation imposed by these flux density restrictions on the ERP from a synchronous satellite. The -130 dbw/m^2 total flux restriction limits satellite ERP to 31 dbw, while the spectral density restriction for FM of -149 dbw/m^2 per 4 Kc/s band limits satellite ERP to the range 39-48 dbw, depending upon the bandwidth of the RF signal. The curves for satellite ERP vs. flux in a 4 Kc/s channel are based on the following assumptions:

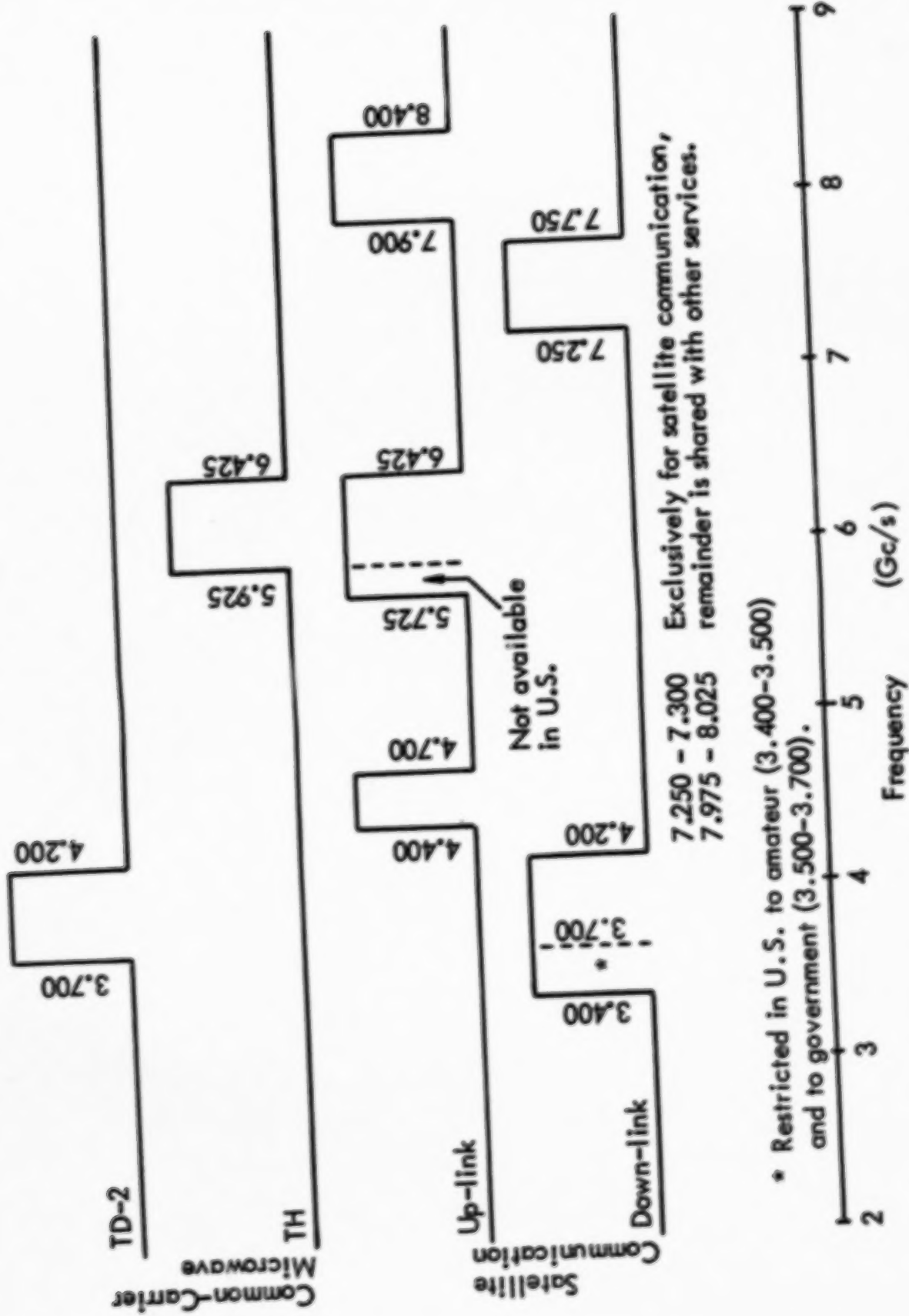


Figure 2.2 Frequency Allocations

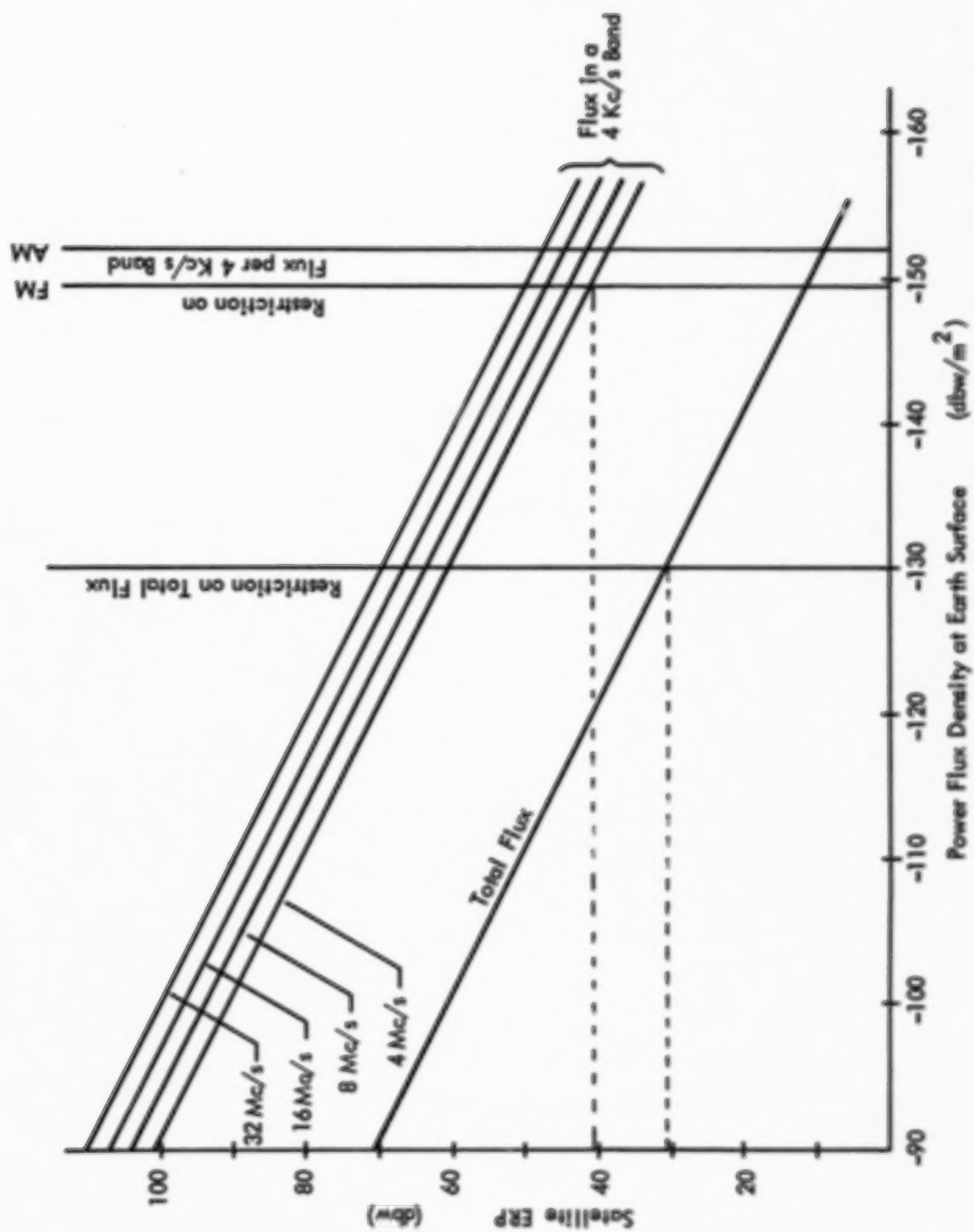


Figure 2.3 ERP vs. Power Density

- The video bandwidth is 4 Mc/s.
- The power density distribution of the satellite signal is uniform over the RF bandwidth (i. e., a flat transmitted spectrum).

There are several papers (CCIR, USPC IV/122 and IV/192-E) which claim that the restriction to -149 dbw/m^2 per 4 Kc/s band for FM, and the 3 db tighter restriction for AM are justified. These calculations were made for a synchronous satellite positioned on the main beam of a common-carrier relay antenna. The interference produced by this situation may approach, but not exceed, the acceptable limits of interference for telephone channels set forth by the CCIR. In data furnished to CCIR Study Group IV (CCIR, 21 August 1964), it has been shown that beam intersection will occur only if the satellite is positioned above the Atlantic or the Pacific Ocean. For a domestic satellite positioned near the central meridian of the United States, the beam-intersection computations ought to be modified by the gain of the common-carrier antenna in the direction of the satellite. This suppression of interference by the vertical pattern of the common-carrier antenna allows a higher tolerable level of power density. Typical patterns for microwave antennas used in common-carrier systems are given in Section 3.1.

The elevation angle of the satellite signal at any point on earth can be obtained from Figure 2.4. For a given position of the satellite, the angle of elevation of the satellite as viewed from each point in the continental United States may be found, and the minimum of these angles of elevation selected.

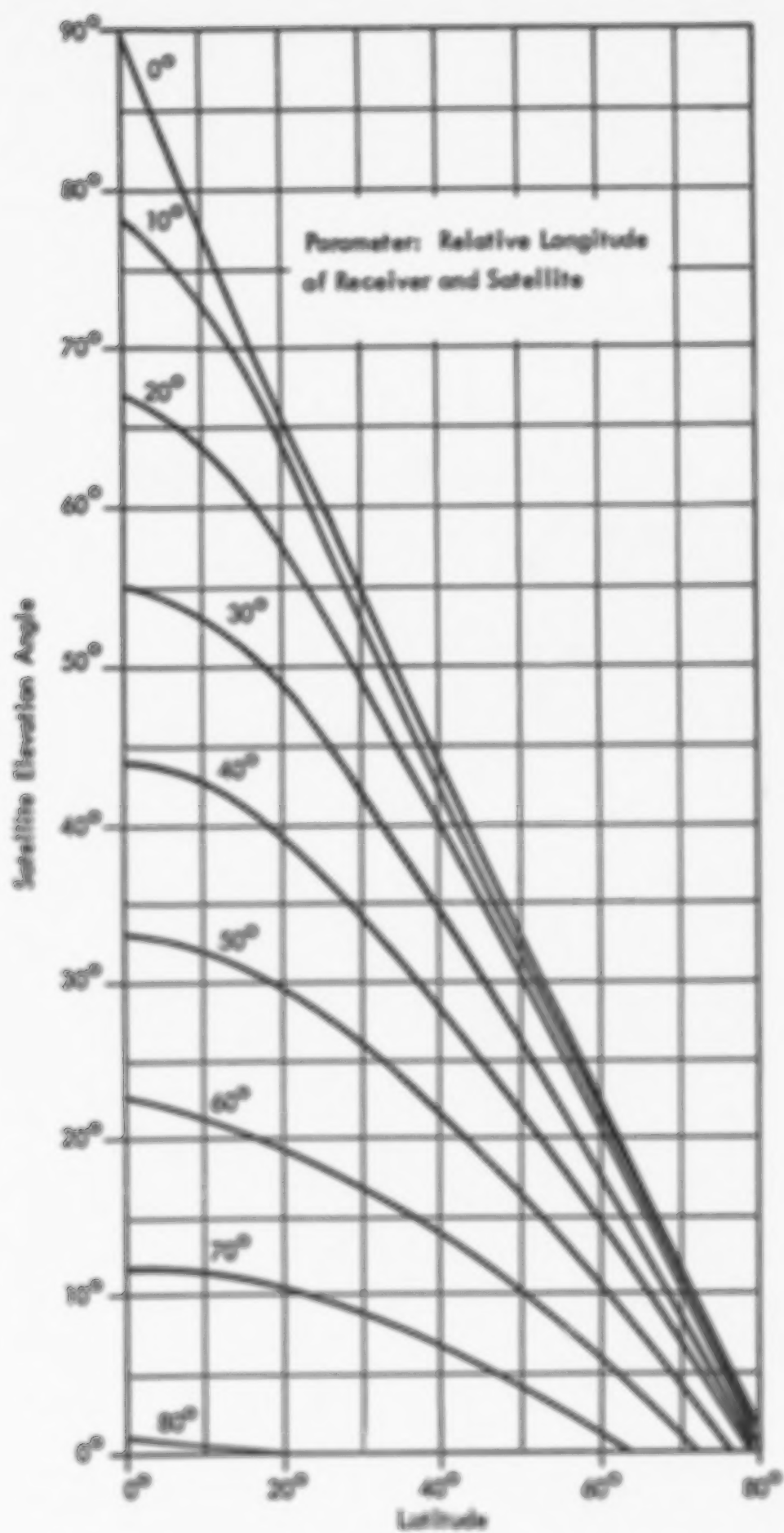


Figure 2.4 Satellite Elevation vs. Latitude and Relative Longitude

The resulting minimum angle of arrival for each position of the satellite is shown as the curve marked 0° in Figure 2.5. In the calculations, a maximum latitude of 47° was used for the continental United States. For each position of the satellite, the direction of arrival was determined at the microwave relay station in the United States most distant from the satellite. This corresponds to the point of minimum elevation of arrival of the signal from the satellite. The worst case assumed in this study corresponds to a common-carrier antenna elevation of 5 degrees, pointed in azimuth at the sub-satellite point, and located geographically at the worst point in the coverage area. The angle of arrival α of the satellite signal referenced to the main beam of the common-carrier antenna is then found and plotted in Figure 2.5 as a function of satellite longitude. Using the calculated values of α , the increased antenna interference suppression can be estimated from the antenna pattern shown in Figure 3.1. The suppression provided by the antenna directivity can be translated into an increase of the tolerable level of power density. Figure 2.6 shows the power density vs. satellite position which would create an equivalent interference with a microwave receiver as would a satellite on the axis of the microwave antenna beam operating at the present power limit.

A satellite may create interference through the antenna side lobes of each of a series of stations in a microwave network. In analyzing this problem, we assume the reference relay network of 50 stations suggested by CCIR, and an interference of the same low order of magnitude occurring in each station.

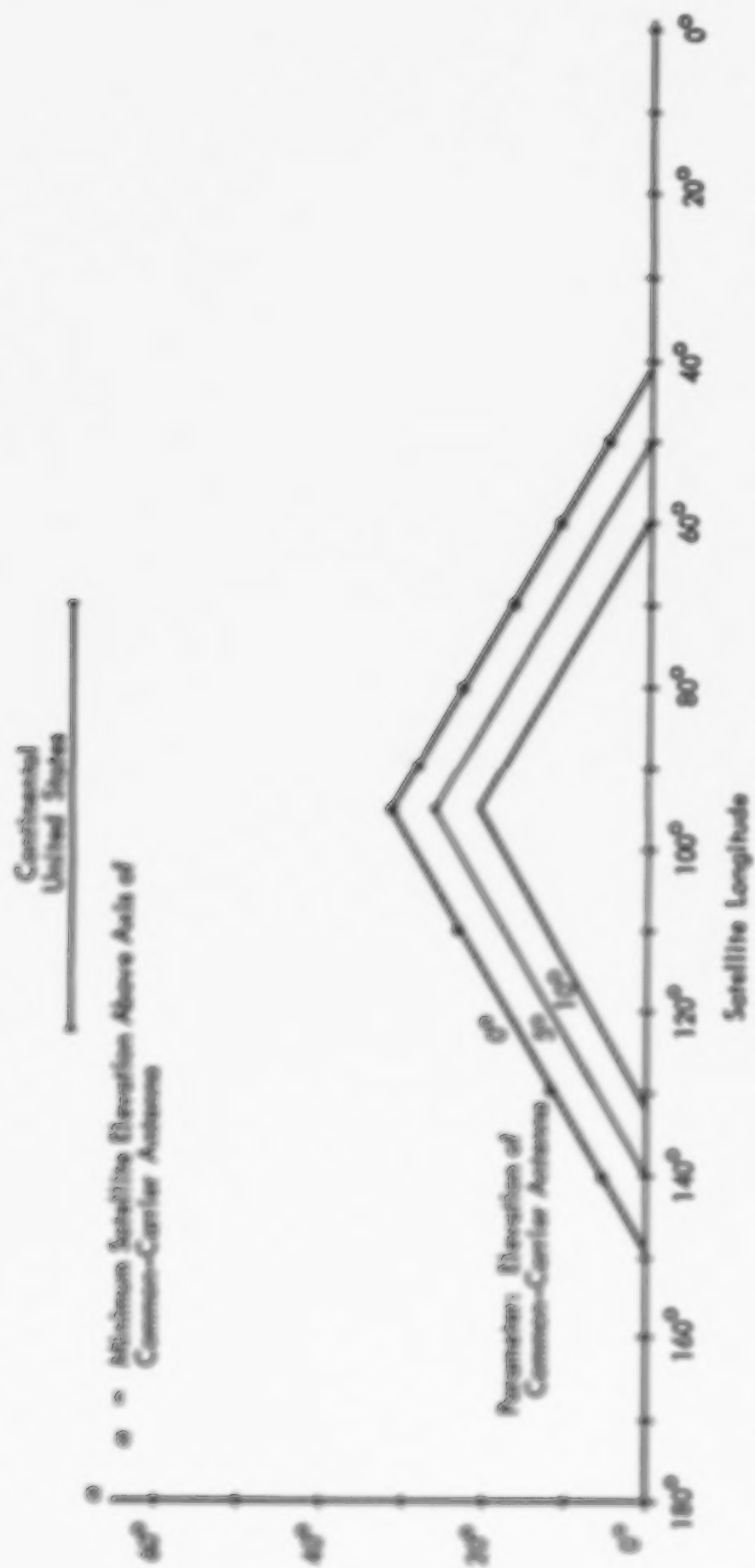


Figure 2.5 Satellite Elevation Above Axis of Common-Carrier Antenna vs. Satellite Longitude

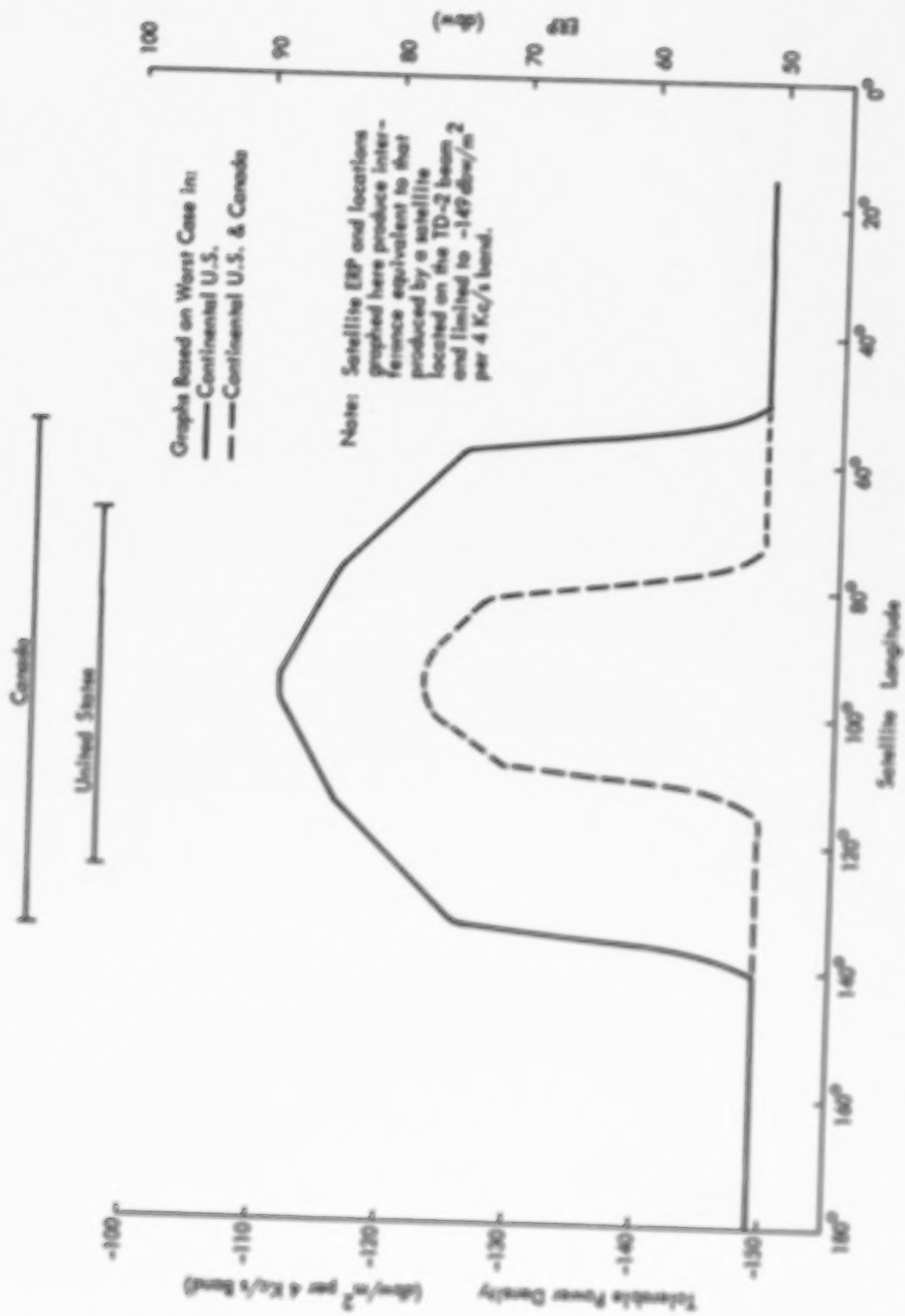


Figure 2.6 Tolerable Power Density Level and ERP vs. Satellite Longitude

Under these conditions, the tolerable flux level would be reduced by a factor of 50, i.e., 17 db. Even when the values plotted in Figure 2.6 are reduced by 17 db, there still remains ample margin for increase in satellite ERP without creating excessive interference with the common-carrier microwave systems. Thus, the limit of -149 dbw/m^2 per 4 Kc/s band may be increased when the TV distribution satellite is emplaced in the longitude window.

The directivity pattern used in computing the longitude window of Figure 2.6 corresponds to an antenna with less than the best available side-lobe suppression. The allowable increase in satellite ERP would be even greater if only antennas such as those described in Figure 3.1 are considered.

The recommendations made by CCIR Working Group IV at the meeting in Oslo in July 1966, allow small increases in satellite ERP for high angles of arrival. The Oslo meeting recommended that the restriction on spectral density be changed to $(-152 + \theta/15) \text{ dbw/m}^2$ per 4 Kc/s band, where θ is the angle of arrival of the interfering signal above the horizon. Assuming the use of common-carrier antennas of reasonable directivity, it would seem more appropriate to increase the coefficient of θ in the Oslo rule from 1/15 to possibly 1/4 or 1/3.

The Oslo meeting also recommended that the -130 dbw/m^2 restriction on total flux density be abandoned. Assuming the existence of limits on spectral density, such as the present limits or modified limits as suggested above, restrictions on total power density are unnecessary.

A possible constraint on ERP in the BNS down-link is imposed by the consideration of potential interference to the earth station receivers of the global commercial communication satellite (Comsat) systems.

Assuming a required ratio of carrier to interference of 40 db at the Comsat receiver terminals and the same ERP for both the Comsat satellite and the BNS satellite, the two satellites must be positioned so that the Comsat earth station antenna provides 40 db of interference suppression. This can be achieved if the satellites are separated by 3° in longitudinal positioning, assuming an 85-ft Comsat earth station antenna. If 50 db of antenna suppression is required, the satellites must be separated approximately 15° to control the interference to the Comsat earth station. Additional suppression can be obtained by using orthogonal polarizations from adjacent satellites.

In controlling the interference caused by Comsat satellites to the BNS earth station, the interference suppression is provided by the BNS earth station antenna. It will be shown in Section 3.3 that the desired carrier-to-interference ratio considering narrow-band FM interference to the BNS system is 37 db. Although Comsat satellites use wide-deviation FM, the 37-db value is used here for discussion as a pessimistic assumption. For equal ERP from both satellites, sufficient interference suppression will be provided by the BNS antenna if the satellites are spaced 10° apart. Closer spacing can be tolerated if polarization discrimination is utilized.

It is not necessary to restrict further the allowable ERP of the BNS

satellite since compatible operations can be achieved through satisfactory positioning of the satellites. Generally speaking, the natural locations for Comsat satellites are at oceanic longitudes and those of BNS satellites are at continental longitudes; thus, there is no present and little future conflict in locating satellites for the domestic TV and international communication services.

A closely related question is why Comsat has experienced such difficulty in siting a very small number of terminals in the United States for use with its international satellites, yet BNS expects to site 223 earth terminals for use with its domestic satellites. The explanation rests on two essential differences between the present Comsat system and the proposed BNS system:

First, the down-link beam from the international satellite is very much wider than for the BNS satellite (approximately 17 degrees compared with 3 degrees). The resulting weaker signal from the international satellite requires the use of a much larger antenna and more sensitive receiver in its associated terminal.

Second, the antenna at an international terminal scans a sector of the equatorial belt. At times, the antenna may be depressed to receive signals with low angles of arrival. Under these circumstances, the terrestrial microwave facilities are likely to interfere with the highly sensitive international terminal.

In contrast, the stronger signals from domestic satellites arrive at a high angle at any BNS earth terminal. The suppression of unwanted signals through high antenna directivity coupled with appropriate site shielding would permit location of BNS terminals in close proximity even to major metropolitan areas.

2.3 Restrictions on Earth Stations

Preliminary studies show that a domestic satellite TV distribution system such as the proposed BNS system is feasible within present restrictions on interference. The only question is how restricted the siting problem becomes in metropolitan areas where the density of common-carrier facilities is maximum. In these areas, the various interference problems must be studied in detail to determine the extent to which the BNS system is restricted and to estimate the resulting increases in system cost.

There is no problem of controlling interference between BNS earth stations and Comsat earth stations, nor between BNS satellites and Comsat satellites. Consideration must be given to possible interference from the BNS earth station transmitter to the satellite receivers of other Comsat systems. It has been proposed that the ERP from common-carrier facilities in the direction of the synchronous equatorial belt be limited to 47 dbw. The ERP from a BNS earth station at a major network terminal will be less than 47 dbw for angular offsets greater than 10° from the axis of the antenna.

The required longitudinal separation between BNS satellites and other Comsat satellites to control interference from a Comsat earth station transmitter to a BNS satellite is dependent upon the transmitter power of the Comsat earth station. If the Comsat earth station radiated power is 10 db above the BNS up-link radiated power, the gain of the Comsat antenna in the direction of the BNS satellite must be less than 6 db to maintain a 37 db carrier-to-interference

ratio. This is achieved if the longitudinal spacing between satellites is approximately 15° .

The main problem in preventing mutual interference between the BNS system and other existing and planned systems comes down to potential interference between BNS and common-carrier terrestrial microwave systems. In this study, these interference situations are divided into the following four cases for convenience:

- Case 1 Common-carrier interference at the BNS satellite.
- Case 2 Common-carrier interference at the BNS earth station
- Case 3 BNS satellite interference at the common-carrier receivers.
- Case 4 BNS earth station interference at the common-carrier receivers.

Cases 1 and 4 occur in the 6 Gc/s band (5.925-6.425 Gc/s), while 2 and 3 occur in the 4 Gc/s band (3.700-4.200 Gc/s).

These interference problems are important to the design and the economics of the BNS system through the restrictions they impose on the feasible range of various system parameters. For example, to control Case 3 interference, an upper limit must be placed on satellite ERP. The resulting lower limit on earth station sensitivity then poses a potential increase in system cost since the earth stations greatly outnumber the satellites in the proposed BNS system.

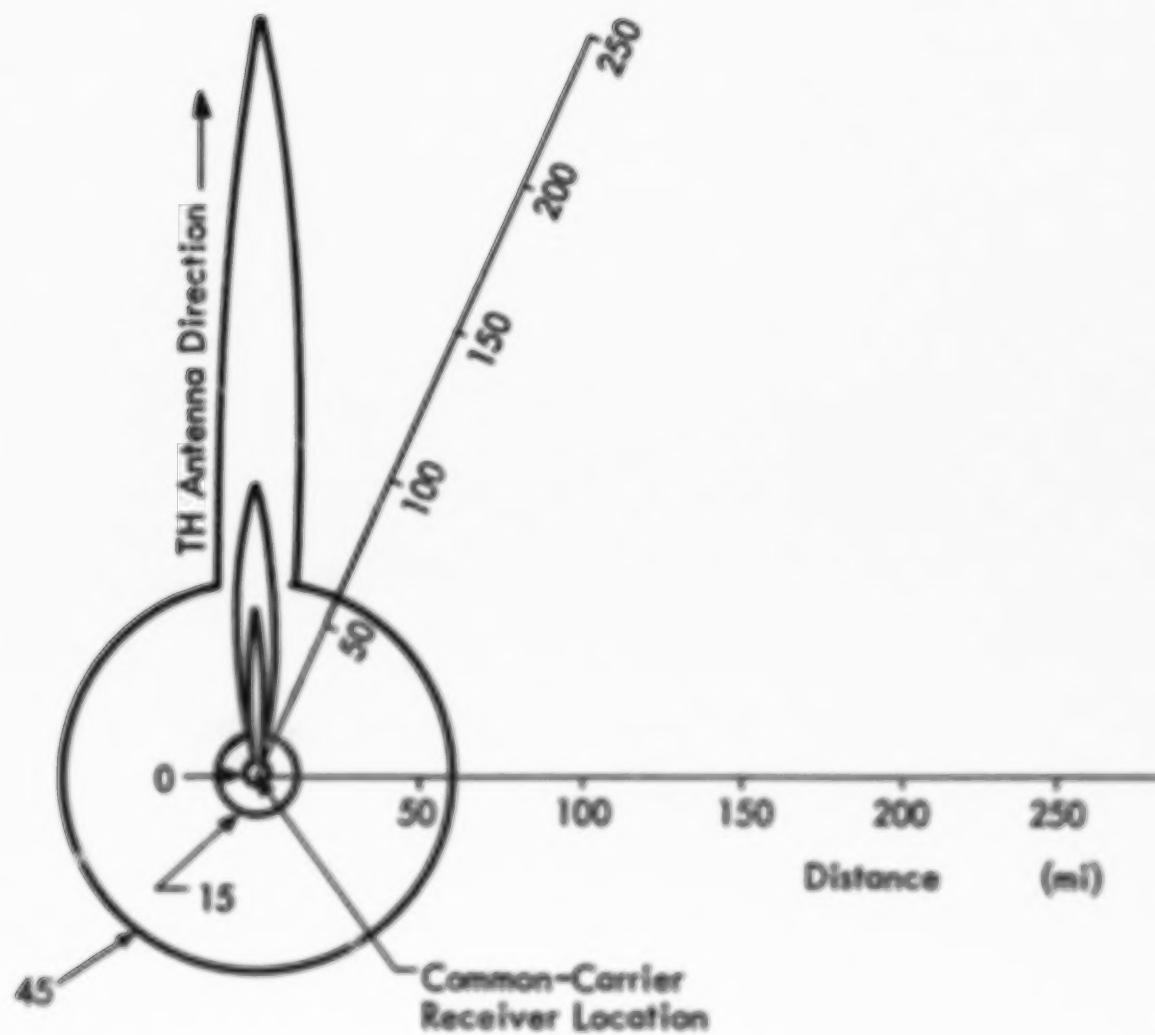
Another example is the possible restriction on location of earth stations in areas near many potentially interfering microwave beams. Or, as shown in Figure 2.7, the location of an earth station may be restricted to limit the interference it produces at some nearby common-carrier receiver. Problems of this sort become quite involved and must be considered in detail as in the sample problem in Section 4. Feasible solutions to these problems may require that some earth stations be located one or more microwave hops away from the locations desired. The cost of the supplemental terrestrial links required over and above the minimum number possible must be included in the total cost of the BNS system and regarded as elements of cost required to satisfy interference criteria.

In summary, interference criteria affect system design mainly through restrictions on the BNS earth stations. These restrictions increase system cost in three ways.

Key parameters must be fixed at values other than those required for minimum cost.

Side-lobe suppression techniques such as shielding, improved antennas, etc., must be incorporated in some of the earth stations and common-carrier facilities located in the metropolitan area.

Supplemental terrestrial links are required to permit some earth stations in metropolitan areas to be located more than the minimum number of microwave links away from the locations desired.



Note:

Parameter is the power radiated (dbw) in the horizontal plane from an Earth station. Interference at the TH receiver is tolerable for all locations of the Earth station outside the contour.

Figure 2.7 Interference Contours around TH Receiver

3. Interference Characteristics

In this section, the characteristics of the BNS system and of the common-carrier microwave relays that pertain to the interference problem are presented along with the tolerable levels of interference for these systems. Various interference phenomena are described briefly and the magnitudes of their effects are estimated.

3.1 Characteristics of Terrestrial Microwave Relays

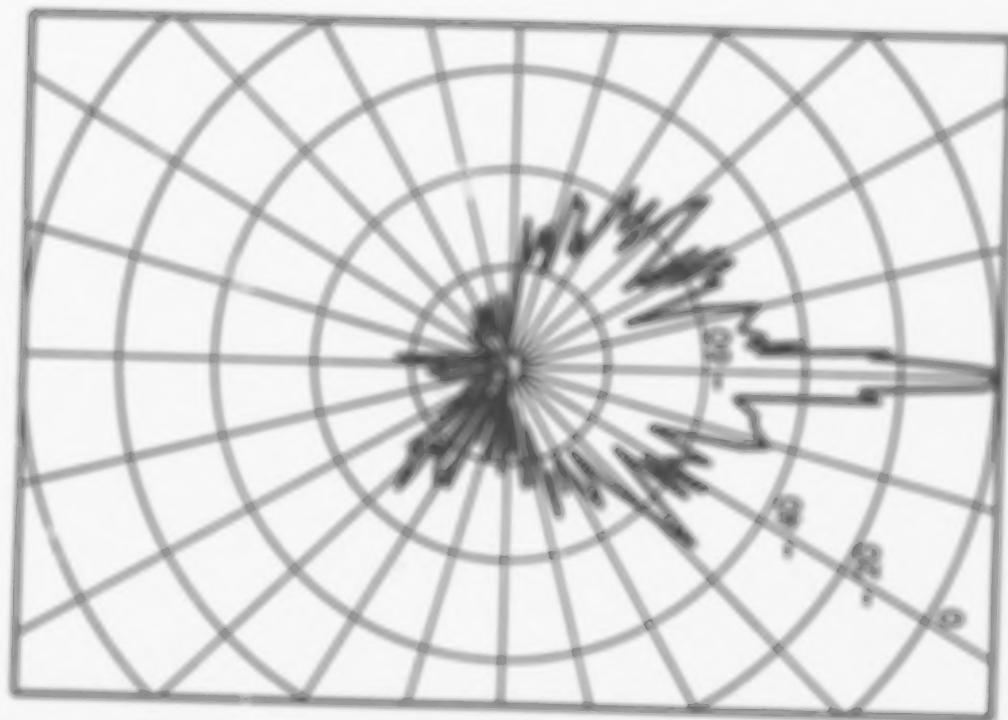
Most of the interference calculations in this study are based on the TD-2 microwave relay systems of the AT&T Company (Roetken 1951) and the newer TH system (Kinzer 1961). The TH system is designed to use the same towers and antenna as the TD-2. Selected characteristics of the TD-2 and TH systems are given in Table 3.1 and typical antenna patterns (gain in db relative to the main beam) are shown in Figure 3.1 for 4 Gc/s operation. The same antenna, shared by the TH system at 6 Gc/s, has a proportionately narrower main beam.

Consideration has also been given in this study to common-carrier microwave relays other than the TD-2 and TH systems but operating in the same bands. Many of these systems use antennas, such as those described by Figures 3.2 and 3.3, which have much less side-lobe suppression than the horn reflectors used by AT&T.

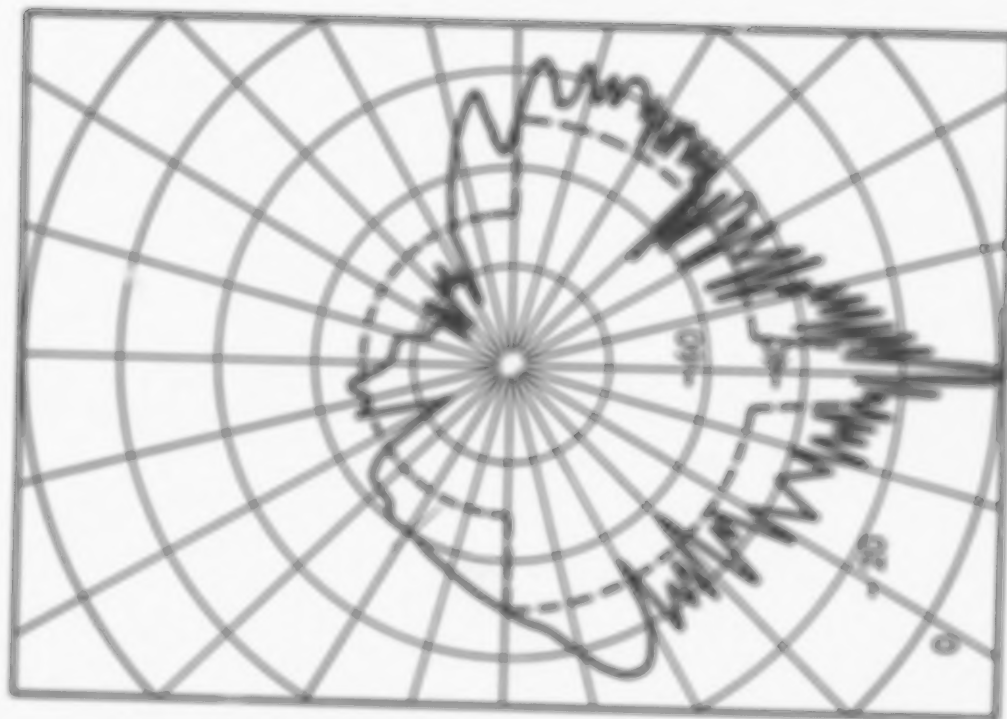
Table 3.1 Characteristics of Microwave Relay Systems

	TD-2	TH
Frequency Band	3700-4200 Mc/s	5925-6425 Mc/s
Multiplexing	Frequency Division	Frequency Division
Modulation	Low-index FM	Low-index FM
Signal Bandwidth	4 Mc/s	10 Mc/s
Transmitter Power (Per Channel)	-3 dbw	7 dbw
Antenna Gain	40 db	43 db
Beamwidth	1.65°	1.15°
Received Carrier Power	-68 dbw	-57 dbw
Working Channels (max.)	6	6
Channel Capacity	1860 TP or 1 TV	1860 TP or 1 TV
Channel Spacing	20 Mc/s	20 Mc/s
Relay Spacing (avg.)	25-30 mi.	25-30 mi.

Stanford Research Institute has published measurements of TD-2 field strengths in the vertical plane (Turner 1965). Results of flights over a TD-2 station equipped with two horn reflectors transmitting on 3.77, 3.85, and 4.01 Gc/s are shown in Figure 3.4 where the radial scale is gain in db above an isotropic radiator. These measurements show the pattern of actual



(a) Horizontal Pattern



Up — — — — — Down

(b) Vertical Pattern

Non Reflective Antenna at 2.74 GHz

— Measured Pattern for Vertical Polarization

- - - - - Estimated Envelope for Horizontal Polarization

Figure 3.1 Vertical and Horizontal Pattern of TD-2 Antenna

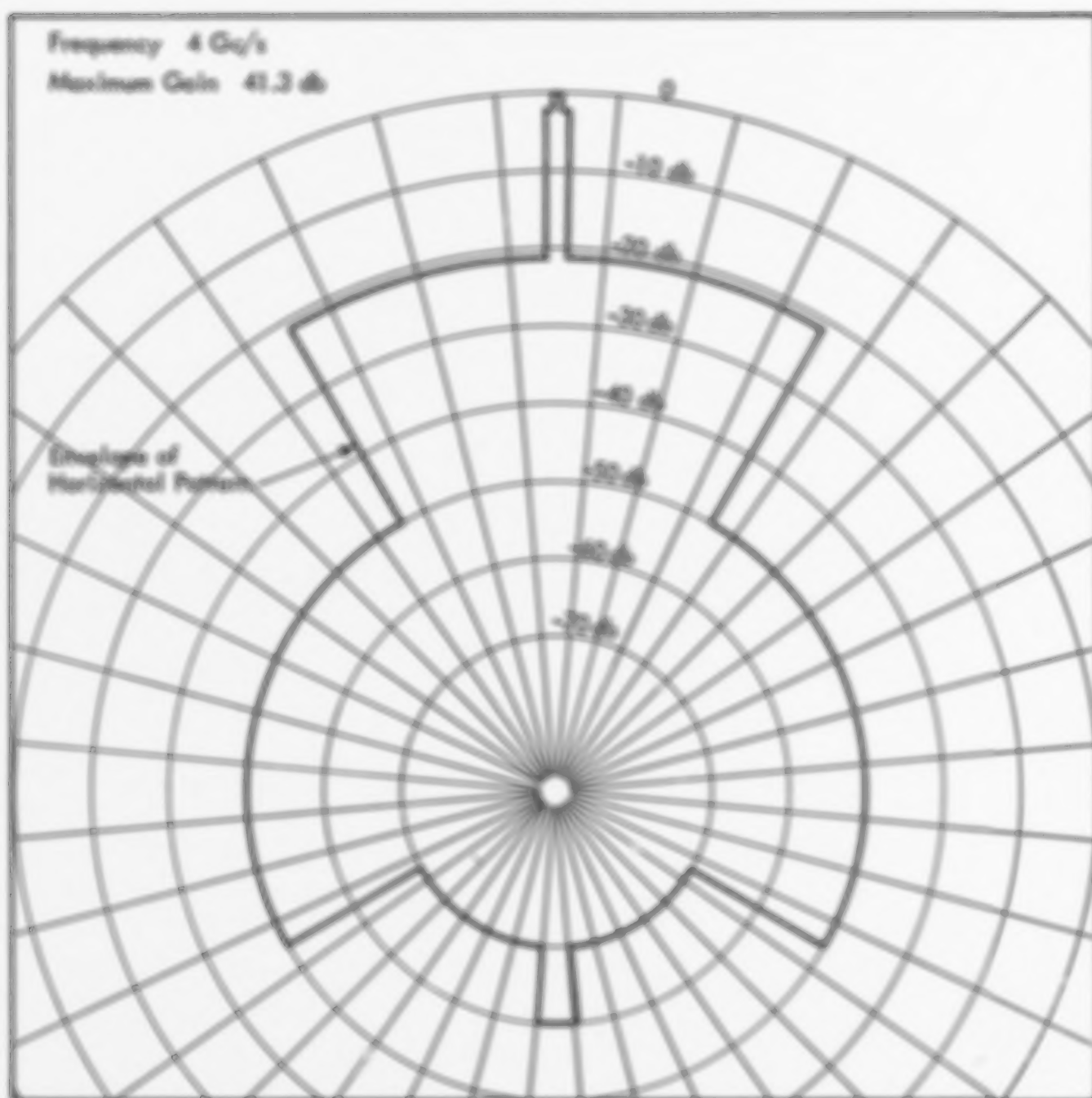


Figure 3.2 Pattern of Parabolic Antenna for Microwave Relay Service

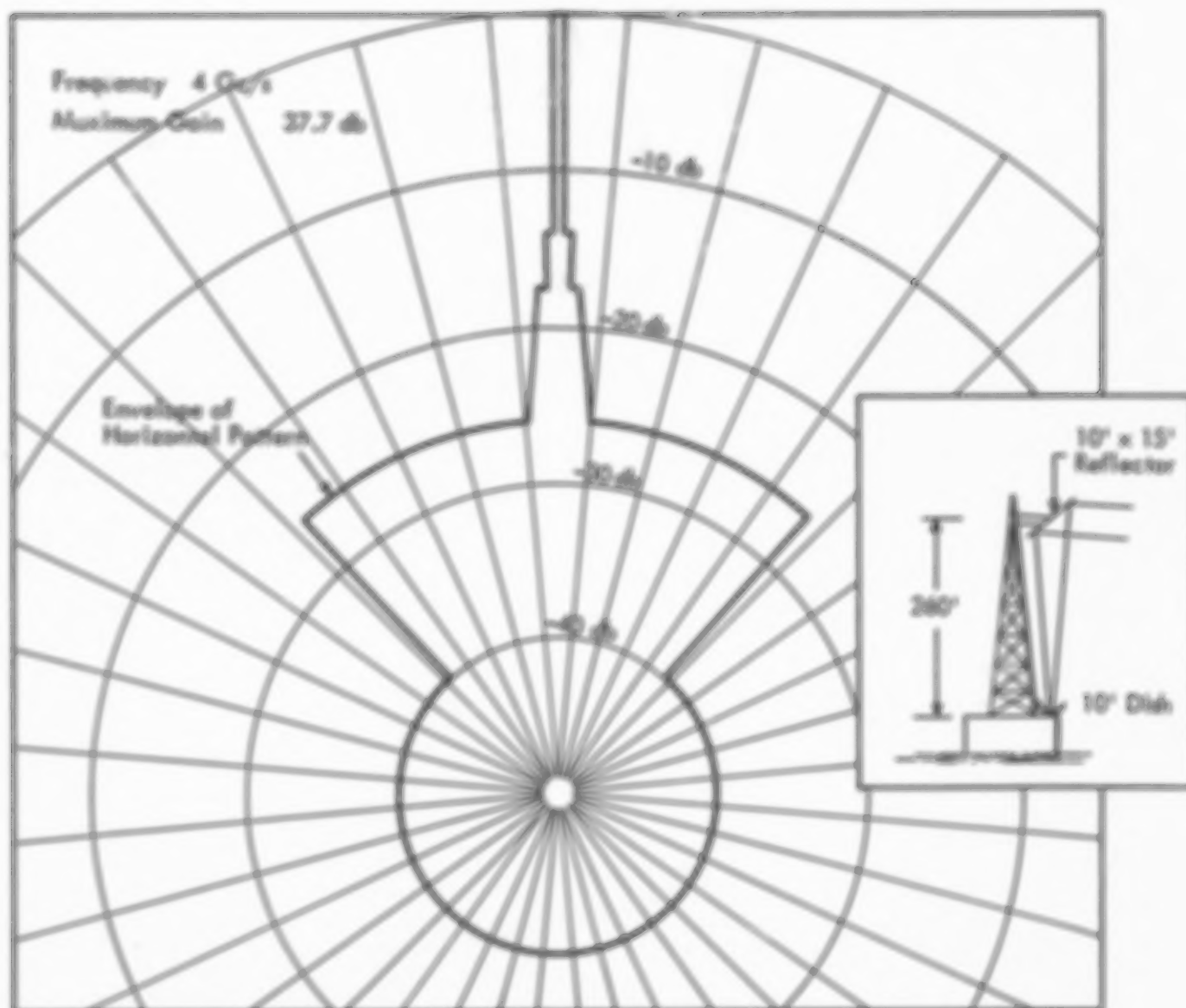
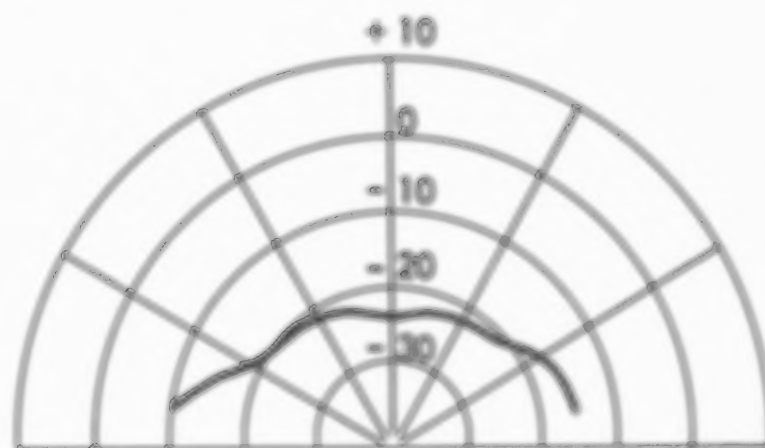
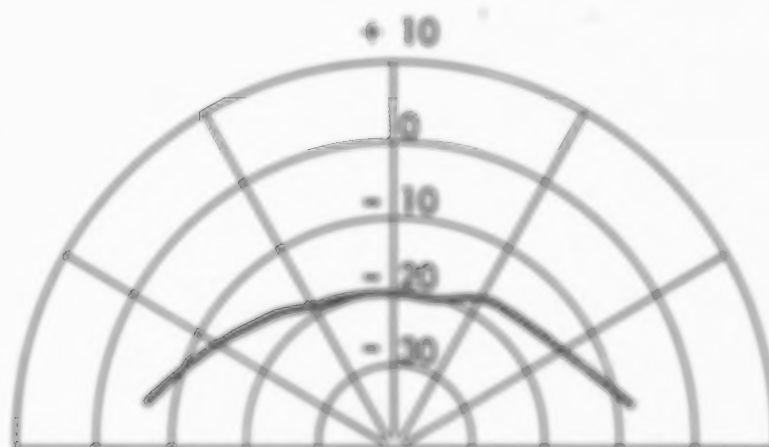


Figure 3.3 Pattern of Periscope Antenna for Microwave Relay Service



(a) Flight Azimuth 51°

(b) Flight Azimuth 115°



Notes:

Gain vs. elevation angle was measured in B-25 flight at 12,000 ft over a pair of TD-2 horn reflectors at 38.1° N, 122.6° W., directed at azimuths 143° and 342° .

Figure 3.4 Aircraft Measurements of Microwave Antenna Pattern

installations in the vertical and horizontal planes through the main beam. More field measurements of this sort would be helpful in further study of the problem.

3.2 Characteristics of BNS-3

Preliminary studies of system design economics and interference considerations have been used to determine a range of values for each key parameter of the system. The system design problem is then to satisfy the interference limits at minimum total system cost.

The solution of each interference case will narrow the range of values of a given number of system parameters. Interference Cases 1 and 3 negligibly constrain the selection of system parameters.

3.2.1 Cases 1 and 3

Case 1 interference is that produced by 6 Gc/s common-carrier transmitters at the satellite receiver. It is clearly desirable to provide signal levels in the up-link sufficient to suppress any interfering signal. Since it is relatively easy to provide the necessary levels of ERP in the earth station, other interference situations must be considered in determining limits on up-link ERP.

Case 3 interference is related to the allowable flux density produced at the surface of the earth by the satellite transmitter. It appears that economic considerations of the BNS system will lead to satellite ERP values less than that which would interfere with common-carrier receivers in the 4Gc/s band.

The major interference problems which must be taken into account in the selection and specification of system parameters arise from considerations of Cases 2 and 4, both of which pertain to terrestrial interference paths.

We will discuss the parameters of the BNS system which will determine the level of interference in these two cases. We will show in Section 4, through a specific example, how the selection of these parameters can influence the siting of earth stations in the BNS system.

3.2.2 Case 2

The tolerable level of common-carrier interference at the earth station is determined by the BNS carrier power at the receiver terminals, i.e., the ratio of the two power levels is significant. To reduce interference, the BNS carrier power must be increased or the interference from the common-carrier must be decreased. The BNS carrier power level is determined by the main-lobe gain of the BNS earth station and the satellite ERP. Since the gain of the satellite antenna is constrained by the desired time-zone coverage, the satellite ERP can only be changed by a costly increase of transmitter power in the satellite. The most economical way of increasing the BNS carrier power received is by increasing the size of the antenna in the BNS earth station. However, such a change will increase the amount of precipitation scatter from common-carrier transmitters, an effect which we will later show to be potentially significant.

Assuming that the the transmitted signal and interfering powers are fixed, direct Case 2 interference can be controlled only by changing location or reducing the effective horizontal gain of the antenna in the BNS earth station. The latter may be achieved by suitable site shielding or by improved antenna

design. In the sample problem of Section 4, we will show that the effective horizontal gain for INCS earth stations in metropolitan areas should be about -24 db relative to an isotropic radiator. This value includes the effect of site shielding.

3.2.3 Case 4

For interference over the direct path, the interfering flux density in a common-carrier facility is determined by the earth station ERP. In Section 4, we will show that the Case 2 interference over the direct path predominates and considerations related to that type of interference will dictate the selection of the system parameters. Interference due to the scatter path is determined by the transmitter power and the main-lobe gain of the INCS earth terminal. The main-lobe gain of the INCS earth terminal generally should not be reduced to improve the situation for Case 4 interference since such a change would reduce the desired signal power received and could increase Case 2 interference.

3.3. Tolerable Levels of Interference

Table 3.2 summarizes the allowable levels of interference at the appropriate receiving installation for the various interference cases under consideration. In each case the level of interference is derived from a system specification or an appropriate CCIR recommendation.

3.3.1 Case 1

An interfering radio relay signal appearing within the passband of the satellite up-link will appear as a strong carrier spike with sidebands that are

Table 3.2 Tolerable Levels of Interference at Receiver Terminals

Case	Interference Conditions	Frequency (Gc/s)	Interference Path	Applicable Specification	Tolerable Interference at Receiver Terminals (dBw)	References
1	Common Carrier to BNS Satellite	6	Direct	$\frac{C}{T} = 37 \text{ dB}$	-129	Section 3.3
2	Common Carrier to BNS Earth Station	4	Direct	$\frac{C}{T} = 37 \text{ dB}$	-143	Section 3.3
			Scatter from Side-lobe	$\frac{C}{T} = 37 \text{ dB}$	-133	
			Scatter from Main-lobe	$\frac{C}{T} = 37 \text{ dB}$	-123	
3	BNS Satellite to Common-Carrier Relay	4	Direct	-148 dBw/m ² per 4 Kc/s channel; 500 pwp	-119.5	Figure 2.6 and (CCIR 1963)
4	BNS Earth Station to Common-Carrier Relay	6	Direct	500 pwp	-119.5	Section 3.3 and (CCIR 1963)
			Scatter from Side-lobe	40,000 pwp	-100.5	
			Scatter from Main-lobe	40,000 pwp	-100.5	

negligible as far as interference effects are concerned, since the terrestrial microwave system is basically a low-deviation system. The spectral density of the Bell System TD-2 sidebands, for example, is 74 db per c/s below the unmodulated carrier level (Curtis 1962). To illustrate the interference problem for a typical satellite communication application, a calculation will be made for the case of a TV transmission via the satellite link.

When the desired down-link signal is such that energy is concentrated in a fairly narrow band, such as might be produced when a picture of large grey area is transmitted, the common-carrier spike will produce a sinusoidal base-band tone which will superimpose an interference pattern on the received picture. Threshold observations have been made to determine acceptable signal-to-noise ratios for this type of interference as a function of frequency (BTL 1964). The requirement is stated in terms of the ratio of peak-to-peak signal voltage to the root-mean-square value of the interfering tone.

The ratio of signal to interfering tone is given by

$$\frac{S}{I} = \left(\frac{\text{P-P signal}}{\text{rms tone}} \right)^2 = \left[\frac{\Delta F}{f \left(\frac{I}{2C} \right)^{1/2}} \right]^2 = \left(\frac{\Delta F}{f} \right)^2 \left(\frac{2C}{I} \right)$$

where

ΔF = peak-to-peak deviation of down-link signal

$$= B_{RF} - 2f_v = 40 - 2(4) = 32 \text{ Mc/s}$$

f = frequency difference between desired and undesired signal

$\frac{C}{I}$ = ratio of down-link carrier to interfering carrier

Choosing $f = 4$ Mc/s for the most severe case, and choosing $S/I = 58$ db (BTL 1964, p.389), we have $C/I = 37$ db.

The preceding analysis is based on an absolute worst case. In this regard, the following points should be noted.

- The 58 db of required signal-to-interference ratio previously cited is based on the envelope of the graph of worst interference vs. frequency in the various portions of the video spectrum. The graph itself would show a large number of maxima and minima as the interference frequency approaches and recedes from synchronization with multiples of the line frequency.
- Since the down-link will include a carrier-dispersion signal, the interfering carrier will appear as a band of energy rather than a spike. The interference reduction potential of this technique has not been measured.
- The preceding analysis is based on the physical interference effect considered, which increases with the frequency of the difference between the BNS carrier and the interfering carrier. However, the psychophysical effects may be completely different and the greatest subjective effect may occur at some point other than the upper edge of the video spectrum. In that event, the required carrier-to-interference ratio would be less than 37 db. Subjective interference tests using the proposed BNS signal, including the carrier dispersion component, must be conducted before complete answers can be given to these questions.
- An excavated pit might be used to shield the earth station antenna from common-carrier interference. At least 40 db of pit shielding is feasible and 70 db may be possible with carefully designed pit walls (Hagn 1965). In the sample siting problem analyzed in Section 4.0 below, pit shielding of less than 30 db suffices to isolate the BNS earth stations from common-carrier facilities. This is well within the range of shielding attainable according to measurements made by Hagn of the Stanford Research Institute.

In areas where such installations may not be feasible, additional techniques for interference attenuation are available. Directional selectivity of the Earth station antenna can be improved at the circumference of the parabola to reduce unwanted side-lobes. Also, the antenna feed can be offset from center to reduce unwanted energy in a given direction. A combination of the latter two techniques could achieve additional side-lobe suppression to result in a gain in a selected direction of approximately -10 db relative to an isotropic radiator. Another possibility is to use fences a few meters in width to shield the earth station antenna in selected directions (Ruze 1966). The effect of such fences can be considered independently of the antenna pattern itself if they are located a few hundred meters away from the antenna.

- Consideration ought to be given to assigning INS carrier frequencies to minimize the interference produced in the down-link by TD-2 carriers ($f = 3690 + 20 k$ for $k = 1, 2, \dots, 20$). Tests of the effects of this interference are necessary to determine the optimum assignment which is expected to be near

$$f = 3690 + 40 k \quad k = 1, 2, \dots, 12.$$

An assignment of this sort has the additional value of providing 20 Mc/s at the band edges for commercial and educational audio channels and for INS control and administration.

3.3.2 Case 2

The frequency of occurrence of interference from the direct path of propagation will differ from that of the scatter path. Direct interference will be nearly constant. On the other hand, interference due to precipitation scatter will occur only during heavy rainstorms. The characteristics of the interference will be similar to Case 1 and, therefore, a carrier-to-interference ratio of 37 db or more is desired. Since the most significant interference from the scatter path arrives through the main lobe of the earth station antenna, while the

interference from the direct path arrives from the side lobes, the tolerable flux densities in these two situations will be different. The allowable interfering power at the receiving terminals for each path will be -143 dbw for a BNS carrier power of -106 dbw. The carrier-to-interference ratio applied to the scatter case will be dependent upon the characteristics and frequency of occurrence of the interfering signal. In evaluating the interference, it is appropriate that the frequency of occurrence be matched to the amount of allowable down-time of the system. The current television distribution system of the United States is down about 0.02% of the time. In the proposed BNS system, a signal of reduced quality will be obtained for a similar fraction of the time. Rainfall rates of 30 mm/hr or greater occur about 0.62% of the time in the New York area, and we will use this rate of precipitation in establishing the level of interference at the receiver in the BNS earth station.

3.3.3 Case 3

The allowable power per 4 Kc/s channel from a satellite transmission is 500 pwp (picowatt, psophometrically weighted) at a point of zero reference level when there are two interfering sources (CCIR 1963, Recommendation 367).

Since the common-carrier link uses low-deviation FM, the noise introduced into a typical telephone channel can be computed by determining the power density of the interfering signal compared to the side-band power density of the common-carrier signal. A calculation will be made using the interference level permitted by the latest CCIR recommendation in order to determine the minimum

isolation that must be provided between the two services.

The latest CCIR recommendation states that earth station transmissions shall not introduce more than 1000 pwp in any telephone channel. Assuming that interference to a particular radio relay route may be caused by two different earth stations, the allowance for each is 500 pwp. Since the thermal noise level in a telephone channel under non-fading conditions is about 25 pwp, the allowable interference power density is 13 db above thermal noise.

Assuming a receiver noise temperature of 750°K, the thermal noise power density is -164 dbw per 4 Kc/s channel. Allowing for 3 db of transmission-line loss between the common-carrier antenna and receiver, the allowable interference power density at the antenna terminals is $-164 + 13 + 3 = -148$ dbw per 4 Kc/s channel.

It will be assumed that the earth station is transmitting TV using frequency modulation with an RF bandwidth of 40 Mc/s. It will also be assumed that carrier energy dispersal is employed, using a triangular waveform added to the normal video signal. Using the amount of dispersion recommended in the most recent CCIR report, which results in a 10-percent increase in RF bandwidth, the ratio of the maximum power per 4 Kc/s channel bandwidth to the carrier power is given in db by

$$-(14 + 10 \log \Delta F)$$

where ΔF is the peak-to-peak deviation of the video signal in Mc/s. Using Carson's rule for the RF bandwidth of an FM signal, and applying the 10-percent dispersion

factor, the value of ΔF can be found from the parameters given previously.

$$B_{RF} = 1.1 (\Delta F + 2f_v)$$

$$\Delta F = (B_{RF}/1.1) - 2f_v$$

If the video bandwidth f_v is taken as 4 Mc/s, then $\Delta F = 28$ Mc/s. It follows that the dispersed power per 4 Kc/s channel is 28.5 db below full BNS carrier power.

3.3.4 Case 4

CCIR Recommendation 356 states that, at a point of zero reference level, the allowable interfering power from an earth station is 500 pwp for 20% of the time and 40,000 pwp for 0.02% of the time. In interpreting this recommendation, we have applied the 500-pwp restriction to interference arriving via the direct propagation path and the 40,000 pwp to interference arriving from the scatter path. As in Case 2, direct path interference will be fairly constant. Again, a rain rate of 30 mm/hr will be used in determining the scattered flux as this corresponds to a frequency of about 0.02% of the time in the New York area. The allowable interference is accordingly higher for the scatter path than the direct path.

3.4 Propagation Effects

Several propagation effects will be discussed with emphasis on precipitation scatter.

3.4.1 Direct Path Propagation

The propagation characteristics for interference over the direct path between common-carrier facilities and BNS earth stations are given in Figure 3.5 (Curtis 1962). The characteristic is divided into two regions, the first of which is free-

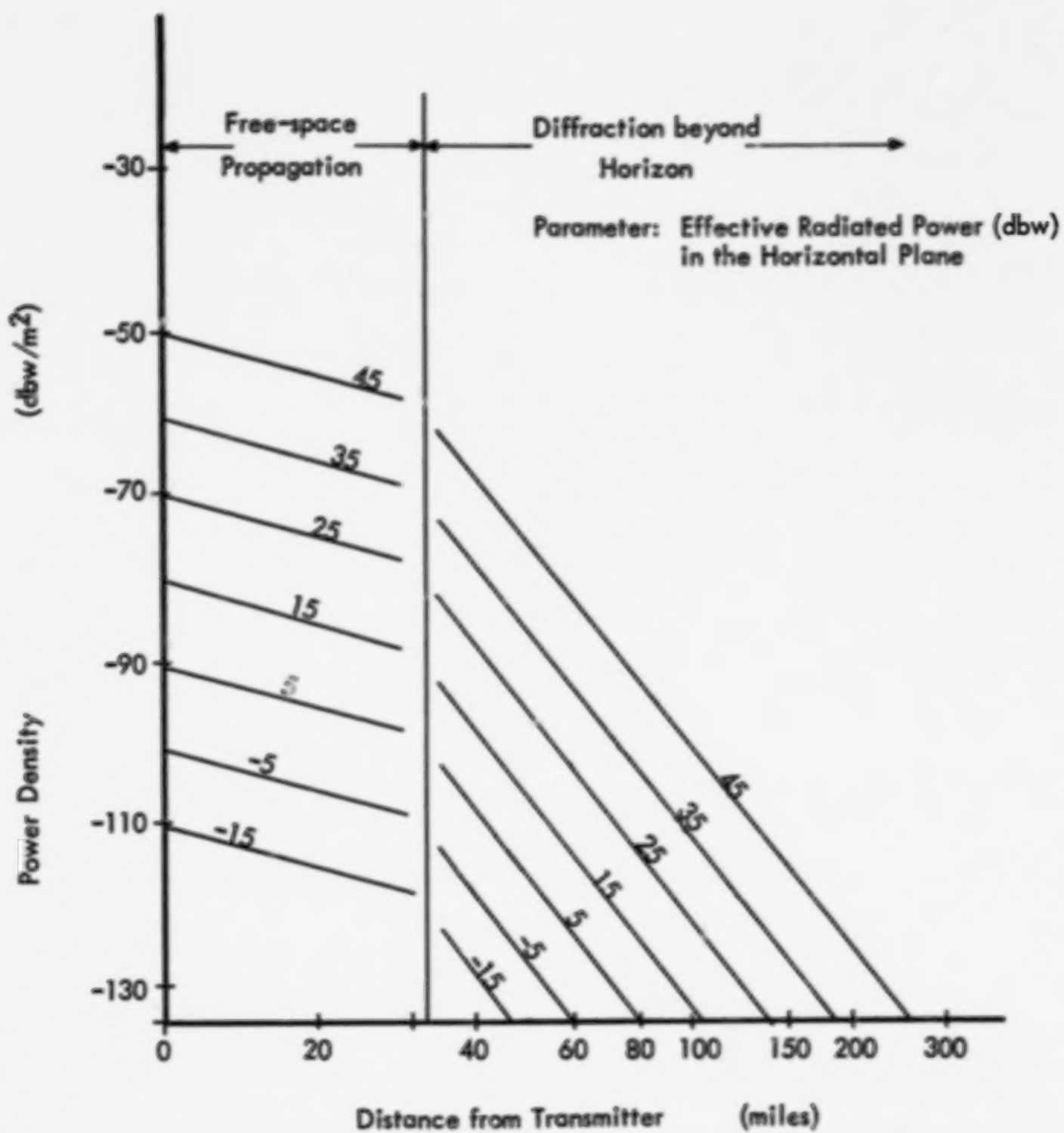


Figure 3.5 Free-space Propagation Characteristic with Diffraction Effect

space or line-of-sight propagation and is predicted using the $4/3$ earth-radius approximation. The diffraction region exists below the radio line of sight beyond the horizon. Figure 3.5 is given for an average terrain condition. The characteristics of diffraction are highly dependent upon the type of terrain and the terrain profile. The diffraction effect can be accurately determined only in individual cases. A way of evaluating the diffraction effect is to construct an earth profile between the transmitter and receiver and find the amount of diffraction by considerations of knife-edge effects.

Besides free-space propagation and diffraction, anomalous modes of propagation may also exist. These include super-refraction or ducting which will effectively extend the line of sight of the transmitted wave indefinitely. It should be pointed out that anomalous propagation characteristics exist predominantly near large water masses which result in inversion of the index of refraction in the atmosphere.

Worst-case considerations of interference effects can be made by assuming free-space propagation within the region of consideration.

3.4.2 Tropospheric Scatter

Tropospheric scatter effects are minimal for the case at hand because of the high elevation angle of the earth station antenna and the low power radiated in directions slightly above the horizontal plane. Tropospheric scatter considerations are usually restricted to cases of low elevation angles. Figure 3.6 shows typical loss curves of tropospheric scatter systems for elevation angles up to 10°

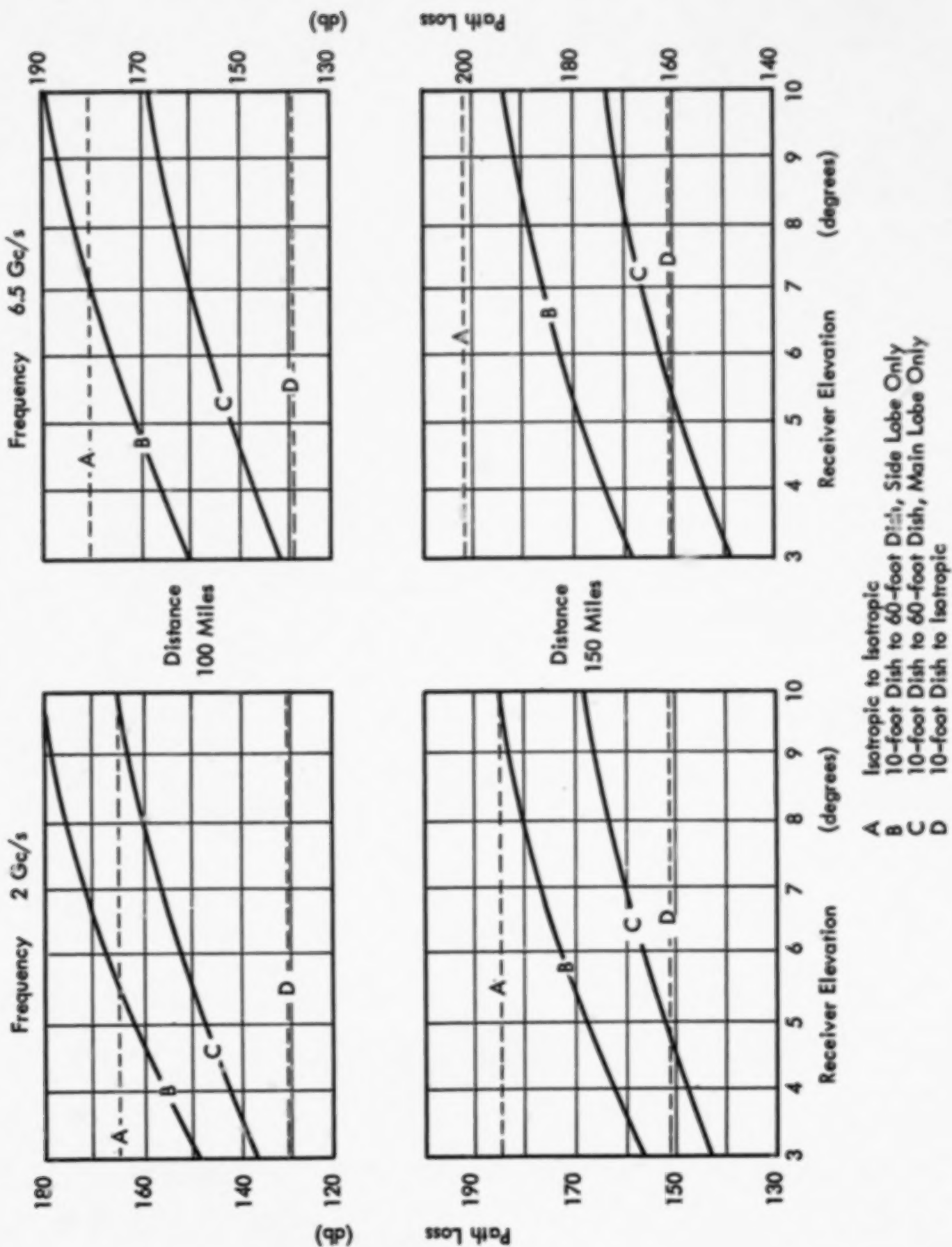


Figure 3.6 Path Loss of Tropospheric Propagation vs. Angle of Elevation

(Hartman 1965). The loss figures given by these curves apply 99.9% of the time. Although the curves are developed for 60-ft and 10-ft antennas, they are easily extrapolated to the BNS system. It is necessary to have a path loss greater than 180 db to avoid Case 2 type interference via troposcatter. Considering Figure 3.6 and the fact that the satellite elevation angle will be greater than 40° , tropospheric loss of greater than -180 db will be obtained at ranges much less than 100 miles. In Section 3.4.3, we will show that control of interference due to precipitation scatter will require that microwave relays be considered at longer ranges. Thus, control of precipitation scatter interference will insure control of tropospheric scatter interference.

3.4.3 Precipitation Scatter

The geometry of precipitation scatter shown in Figure 3.7 applies in principle to all of our interference cases, but only in Cases 2 and 4 are the effects significant. The precipitation scatter path consists of three parts: (1) a direct path from interfering transmitter to (2) the scattering volume, and (3) a direct path from there to the interfered receiver. Free-space propagation is assumed for the two direct paths. It is necessary to estimate the height of common-carrier beams above terrain at various distances from the common-carrier transmitter. For a smooth earth, and using the $4/3$ earth-radius approximation, the height h in feet of the beam at a distance of R miles from a common-carrier transmitter aimed at the radio horizon is given by

$$h = 0.5 (R - 24.5)^2$$

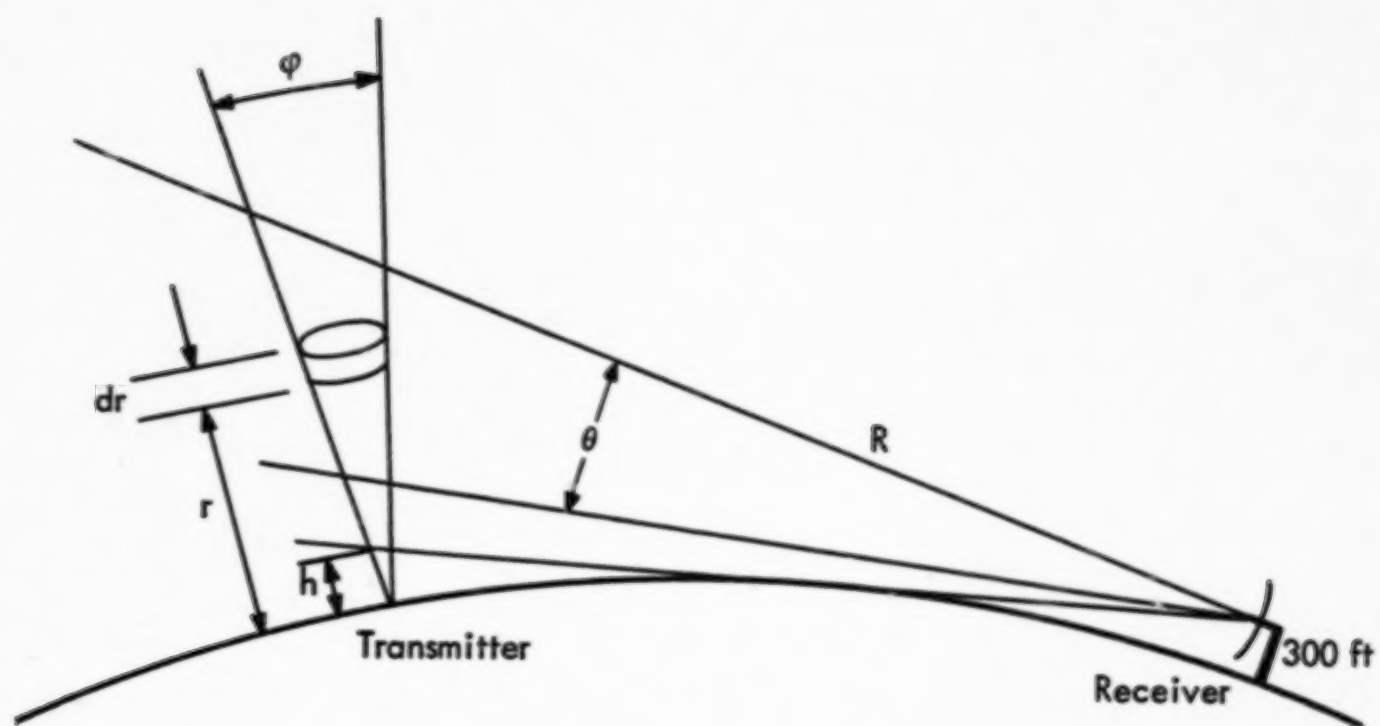


Figure 3.7 Geometry of Precipitation Scatter

Attention will be confined to scatter from rainstorms, since water droplets scatter microwave energy more strongly than snow. This is explained by the large ratio of dielectric constants of the two materials. The backscattering cross-section per unit volume increases with rainfall rate. For the wavelength $\lambda = 5.7$ cm., the backscattering cross-section is given by

$$s = 5.59 \times 10^{-5} Q^{1.6} \quad (3.1)$$

in cm^2/m^3 , where Q is the rainfall rate in mm/hr (Gunn 1954). When the water droplet radius is much less than the wavelength, as is the case here, the scattering intensity is a maximum in the forward and backward directions and a minimum at right angles to the incident energy (Born 1959, p. 650). The minimum is roughly half the maximum, but we will use the backscattering cross-section here as a pessimistic estimate of interference due to precipitation scatter.

We begin our analysis by considering Case 4. Assume that the transmitter is pointed in the vertical direction with power P_t , gain G_t and beamwidth ϕ . Assume that the receiver has a beamwidth of θ , and is located at a height of 300 feet and at a distance R from the transmitter.

Consider an element of volume at a distance r above the transmitter.

$$dV = \pi \left(\frac{\phi}{2} r \right)^2 dr$$

The flux density illuminating this volume element is

$$F_s = \frac{P_t G_t}{4 \pi r^2}$$

The total power scattered from a volume V is then given by

$$P_s = \int_V F_s \, sdV$$

Assuming that all elements of the volume can be seen by the receiver antenna,

one gets for the flux density at the receiver

$$F = \frac{P_s}{4\pi R^2} = \frac{P_t G_t}{16\pi R^2} \left(\frac{\phi}{2}\right)^2 \int_V s(r) dr$$

$$= K \frac{S}{R^2}$$

where

$$K = \frac{P_t G_t}{16\pi} \left(\frac{\phi}{2}\right)^2$$

and

$$S = \int_V s(r) dr$$

Now with $P_t = 50$ w, $G_t = 50$ db, and an up-link beam width of 0.5° , i. e., $\phi = 0.5 \pi / 180$, we find that $K = 1.9$ w. It is convenient to express S in $\text{cm}^2 \text{ft} / \text{m}^3$ and R in miles, and then we have $K = 2.24 \times 10^{-11}$.

We consider two cases. In the first, the receiver beam intersects the transmitter beam, and in the second, it does not intersect.

In the first case, we are interested in calculating the flux F_B in the receiver beam. F_B is the received power density scattered from the volume of

a rainstorm, common to the main beams of interfering and interfered antennas.

We consider only the situation where the beams are positioned so as to maximize the scattered flux received. The height of the total volume of interest is given by $\Delta r = \theta R$ which becomes

$$\Delta r = 92.2R \quad (3.5)$$

for a common-carrier beamwidth of 1.23° , i.e., $\theta = 1.23 \pi/180$, where R is given in miles and Δr in feet.

In the second case, the receiver beam does not intersect the transmitter beam. The flux F_L is the received power density scattered from the volume of a rainstorm in the main beam of the earth station, visible from a common-carrier facility.

In either case, part of the transmitter beam, below height h , will be obscured by the curvature of the earth. If d is the distance to the horizon and R_E is the radius of the earth then

$$d^2 = (R_E + h)^2 - R_E^2 = h(2R_E + h) \approx 2hR_E$$

With the receiver antenna at 300 ft and $R_E = 4000$ mi, then

$$h = 0.5 (R - 24.5)^2 \quad (3.6)$$

where h is given in feet and R in miles.

Figure 3.8 shows a model of a thunderstorm cloud in terms of rainfall rate versus altitude. The model was chosen to exceed all characteristics of a typical thundercloud (Valley 1965, pp 5-11). From 0 to 8000 ft., $Q = 30$ mm/hr and, by Equation 3.1, $s = 0.0067 \text{ cm}^2/\text{m}^3$. From 8000 ft to 24,000 ft, $Q = 60$

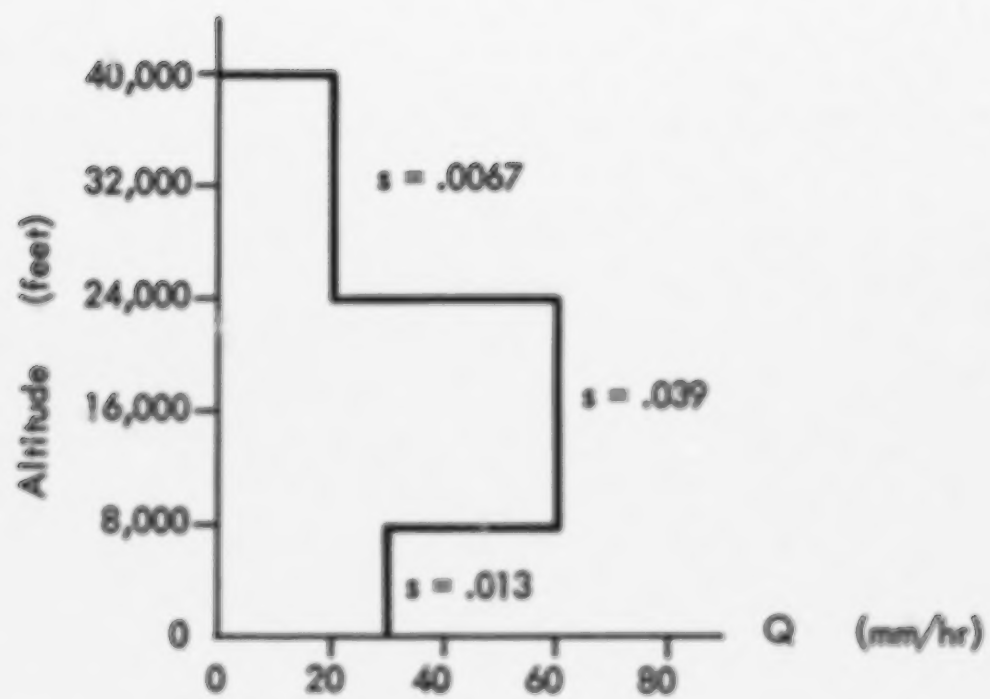


Figure 3.8 Model of an Extreme Thunderstorm

and $s = 0.039$. From 24,000 ft. to 40,000 ft., $Q = 20$ and $s = 0.013$. Based on this model, the quantities S_B and S_L corresponding to F_B and F_L may be calculated from Figure 3.8 and Equation 3.4, with integration limits determined by Equations 3.5 and 3.6. The results of calculation for several values of R are shown in Table 3.3

The values calculated in this example were scaled to fit the interference cases of interest in the sample problem discussed in Section 4. The wavelength used here was selected to facilitate comparison with measured backscatter data (Gunn 1954). Equation 3.1 may be scaled to 4.200 and 6.425 Gc/s in proportion to the fourth power of frequency. It is also necessary to scale F_B and F_L to account for the changes in ERP and beamwidths from the values used in the example above to the interference cases considered in Section 4. The resulting flux densities obtained for Cases 2 and 4 are graphed in Figure 3.9.

Case 2 interference may be analyzed with the aid of Figure 3.7 but with the roles of the receiver and transmitter interchanged. Here we have

$$F_s = \frac{P_t G_t}{4\pi R^2}$$

The power scattered from dV is $sF_s dV$ and the corresponding power density produced at the receiver is

$$\begin{aligned} dF &= \frac{sF_s}{4\pi r^2} dV = \frac{sF_s}{4\pi r^2} \pi \left(\frac{\phi r}{2}\right)^2 dr \\ &= \frac{P_t G_t}{16\pi R^2} \left(\frac{\phi}{2}\right)^2 s dr \end{aligned}$$

Table 3.3 Sample Calculations of Scattered Flux

R (ml)	h (ft)	r (ft)	S _B $\left(\frac{\text{cm}^2 \text{ft}}{\text{m}^3}\right)$	S _L $\left(\frac{\text{cm}^2 \text{ft}}{\text{m}^3}\right)$	F _B (w/m^2)	F _L (w/m^2)
5	0	575	22.4	838	2.01×10^{-11}	7.50×10^{-10}
10	0	1,150	44.8	838	1.01×10^{-11}	1.87×10^{-10}
25	0.12	2,870	112	838	3.97×10^{-12}	3.00×10^{-11}
50	325	5,750	224	836	2.01×10^{-12}	7.48×10^{-12}
100	2,850	11,500	448	798	1.01×10^{-12}	1.79×10^{-12}
150	7,870	17,200	633	730	6.30×10^{-13}	7.28×10^{-13}
200	15,400	23,000	441	450	2.47×10^{-13}	2.52×10^{-13}
250	25,400	28,700	97.8	97.8	3.50×10^{-14}	3.50×10^{-14}
300	38,000	34,500	13.0	13.0	2.37×10^{-15}	2.37×10^{-15}

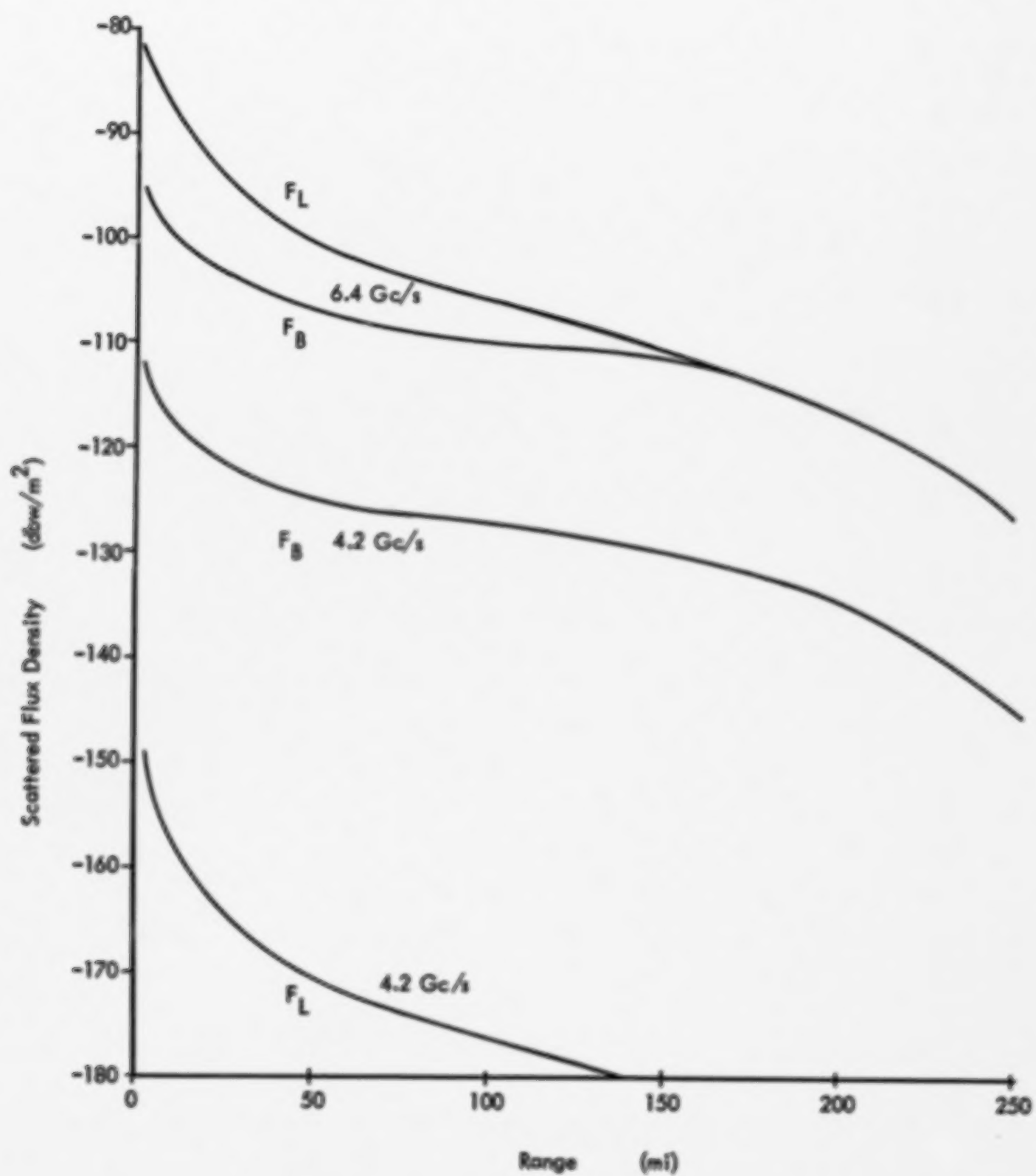


Figure 3.9 Interference Extremes Due to Precipitation Scatter

Thus, the flux density at the receiver due to scattering by the volume V is given by

$$F = \frac{P_t G_t}{16\pi R^2} \left(\frac{\phi}{2}\right)^2 \int_V s dr$$

which has exactly the same form as that obtained in Case 4.

3.4.4 Aircraft Scatter

A potential source of mutual interference between common-carrier facilities and the proposed BNS earth stations is the scattering of signals by aircraft. We consider just those situations where the paths of both the incident and scattered rays are in the free-space region. The power density F in w/m^2 at a common-carrier receiver located R meters from an aircraft flying h meters from a BNS earth station is given by

$$F = \frac{P_t G_t}{4 h^2} \sigma \frac{1}{4\pi R^2} \quad (3.7)$$

where σ is the scattering cross-section of the aircraft in m^2 and $P_t G_t$ is the ERP of the transmitter in the direction of the aircraft.

Measurements of cross-section of various aircraft for backscatter are readily available but values of σ for other scattering angles are not. A reasonable assumption is that σ will not exceed the backscatter cross-section. A paper on this subject prepared for the FCC and the House of Representatives by the Microwave Committee of the Electronic Industries Association suggests a value

of 75 m^2 for σ and we have followed this suggestion (U.S. Congress 1961).

A more complete review of the literature on aircraft scatter is needed, and if the desired data is not available, measurements of σ for various aircraft and aspect angles should be conducted.

Clearly, F increases as h decreases until the point where either the incident or scattered ray enters the diffraction region. Further decrease of h will result in a decrease of scattered power density because of increased attenuation in the diffraction region. Thus, for the high elevation angles of BNS earth station antennas, h is roughly approximated by the aircraft altitude and the worst interference for a given R occurs near the value of h for which the transmission path is tangent to the terrain. As before, the $4/3$ earth-radius approximation is used.

The preceding discussion was based on Case 4 interference. The worst-case result for Case 2 has the same form as Equation 3.7.

Except for the immediate area around major airports, aircraft of large cross-section almost always fly at altitudes of several thousand feet or more. For the purpose of preliminary estimates of aircraft scatter interference, attention is restricted to altitudes between 5,000 and 50,000 feet. For a given BNS earth station and common-carrier facility, the altitude h yielding maximum interference and lying between the altitude limits is easily found from Equation 3.6. In every case of interest, the result is one of the limiting altitudes.

For the case of the scattering aircraft in the main beam of the BNS

earth station, the required coordination distances are given in Table 3.4 for various aspect angles of the common-carrier antenna and various aircraft altitudes. The altitude of greatest interference for each situation is denoted by h_m . These results are based on an ERP of 73 dbw for the BNS earth station and 53 dbw for the common-carrier transmitter.

Table 3.4 Coordination Distances for Aircraft Scatter

Interference Situation	Coordination Distance (mi)		
	$h = 5,000$ feet	$h = 50,000$ feet	$h = h_m$
Case 2			
Main Lobe	100	316	316
First Side Lobe	100	10	100
Other Lobes	10	1	10
Case 4			
Main Lobe	62.5	6.25	62.5
First Side Lobe	10.0	1.00	10.0
Other Lobes	<1.0	<0.10	<1.0

The design procedure used in the sample problem described in Section 4 to control direct interference and precipitation scatter yields BNS earth station

locations which avoid intersections of main lobes of the interfering and interfered beams for all common-carrier facilities within 275 miles of the area considered for siting. Main-lobe to main-lobe scattering for R greater than 275 miles occurs when an aircraft above 37,800 feet flies through the BNS beam, a rare event of short duration.

Much of the potential for mutual interference between BNS beams and common-carrier side lobes is eliminated by the design procedure used to control precipitation scatter. The remaining aircraft scatter situations result in brief intervals of interference occurring rarely because of the small beam width of the BNS earth station. The frequency of occurrence and intensity of these events is considerably greater for Case 2 than for Case 4 interference. By locating the BNS earth station so that the beam does not pass through airways carrying heavy traffic at low altitudes, the frequency of occurrence of these interference events can be kept within tolerable limits.

Typical durations of the aircraft interference events are in the range of 0.1 to 1.0 second. The mode is near 0.4 second corresponding to 200-mi/hr aircraft near 10,000 feet and 600-mi/hr aircraft near 30,000 feet. About two such events per hour can be tolerated by each BNS terminal for a restriction to 0.02% of the time. Location of BNS terminals five miles or more from major airports should be sufficient to keep the probability of flights through the beam within tolerable limits.

A complete analysis of aircraft scatter interference requires a study of

flight patterns and traffic densities in the vicinity of major airports. Also, before this problem can be completely determined, a specification is required that states tolerable interference as a well-defined function of occurrence frequency. Such specifications are currently being considered by CCIR.

4. Location of Earth Stations in the BNS System

In the preceding section, relevant interference phenomena have been described and quantified. The approach now is to proceed to a consideration of the actual interference situations in and near some particular metropolis, e.g., New York City and the surrounding area from Sussex and Cranbury, New Jersey to Bridgeport, Connecticut. This engineering approach is difficult and tedious. However, much of the procedure can be programmed so that computer assistance can be used to reduce engineering costs of repeating the procedure in siting studies required for each BNS earth station.

One of the major system design problems in the BNS system is the siting of the earth stations, since these must connect to TV transmitters that are often located in or near large metropolitan areas which also contain many common-carrier facilities. In the siting of the earth station, interference Cases 2 and 4 must be considered.

The procedure followed here is to consider each interference possibility separately and to determine regions within the overall area that must be excluded. Regions which are not excluded after study of all the various interference situations will be feasible for siting purposes. These acceptable areas can then be evaluated with regard to other criteria and the most desirable location within these acceptable regions selected.

4.1 Design Procedure

The interference conditions which must be considered are the case of the

common-carrier transmitter interfering at the earth terminal receiver via both direct path and scatter path and the case of the earth station transmitter interfering with local common-carrier receivers via both direct and scatter paths. The general procedure in making a site analysis is to first determine the range from the prospective area within which common-carrier facilities must be considered in the various interference cases. Specific interference contours are then determined using the techniques illustrated in Section 3 for each case of interference surrounding the appropriate common-carrier facility. The interference contour surrounding a microwave facility for Case 2 direct path interference is given below.

$$R_2 = (\lambda/4\pi) \sqrt{\rho_2 G_{CH}}$$

where

$$\rho_2 = G_{EH} P_{TC}/P_{RE} \quad (4.1)$$

Similarly, the contour for Case 4 direct path interference is

$$R_4 = (\lambda/4\pi) \sqrt{\rho_4 G_{CH}}$$

where

(4.2)

$$\rho_4 = G_{EH} P_{TE}/P_{RC}$$

$$P_{TC} = \text{the power radiated by the common-carrier transmitter}$$

$$P_{TE} = \text{the power radiated by the earth station transmitter}$$

$$P_{RC} = \text{the tolerable interference level at the common carrier receiver terminals}$$

- P_{RE} = the tolerable interference level at the earth station receiving terminals
- G_{EH} = the gain of the earth station antenna in horizontal plane
- G_{CH} = the gain of the common-carrier antenna in horizontal plane

Using the maximum power permitted by CCIR Recommendation 406,

$P_{TC} = 13$ dbw. From the proposed specifications of BNS-3, $P_{TE} = 20$.

Rounding off the value -119.5 given in Table 3.2, we have $P_{RC} = -120$.

Assuming that the dispersion signal proposed for use in the BNS system, in addition to reducing Case 4 interference, will also reduce the effect of Case 2 interference by as much as 5 db, then $C/I = 37 - 5 = 32$ db. For a carrier power level of -106 dbw at the BNS earth station receiver, we have $P_{RE} = -106 - 32 = -138$ dbw. Any optimism in the assumed 5 db of improvement due to carrier dispersion is offset by the assumption of an ERP 8 db above the maximum level used in the TD-2 system.

With these assumptions, we have

$$\rho_2/\rho_4 = 12.5 \quad \text{and} \quad R_2/R_4 = 5.25 \quad (4.3)$$

These results show that the interference contour for the direct path dominates for the case of common-carrier interference with the earth station receiver. It should be noted that Equations 4.1 and 4.2 are developed for free-space propagation. This is an extreme case.

In considering a specific example, interference contours can be plotted for different values of ρ and the effect in site selection obtained by varying G_{EH}

can be determined. This procedure will help define the required amount of site shielding to provide adequate freedom in siting. The technique for site shielding can then be selected to provide the required value of G_{EH} .

The range of consideration for scatter interference is given in Table 4.1 for the proposed BNS system. The allowable interference at the receiver terminals is translated into power density for the different cases of scatter interference (main lobe, first side lobe, and other side lobes) and then compared with the power density resulting from an extreme case of precipitation scattering shown in Figure 3.9 to obtain the required separations shown in Table 4.1. The interference contours of all beams pointed toward the siting area within the range given in Table 4.1 are then plotted to determine the areas blocked by precipitation scatter considerations. A practical example will illustrate that precipitation is the predominant mode of interference for the main lobe only. The range of possible interference from a common-carrier facility within the main beam will be determined by the precipitation scatter path of interference.

4.2 Sample Problem: New York City

Figure 4.1 shows the positions of microwave facilities within the immediate New York City area. This is the area within which a preliminary site-selection study has been made. The data shown in Figure 4.1 as well as all data which will be used in this example was obtained from the FCC. The area of consideration is approximately defined by a 40-mile radius around New York City.

Table 4.1 Range of Consideration for Rain Scatter

Case	Interference Conditions	Frequency (Gc/s)	Main Lobe or Side Lobe	Tolerable Interference Level (dbw)	Assumed Antenna (db re 1 m ²)	Tolerable Power Density (dbw/m ²)	Range of Consideration (mi)
2	Common-Carrier to BNS Earth Station	4	Main Lobe 1st Side Lobe Other Lobes	-133* -133* -133*	16 16 16	-149 -149 -149	275 7 2
4	BNS Earth Station to Common-Carrier Relay	6	Main Lobe 1st Side Lobe Other Lobes	-100.5 -100.5 -100.5	6.5 -23.5 -43.5	-94 -77 -57	5 <0.5 <0.2

* This level corresponds to C/I = 27 db at the receiver terminals in the earth station.

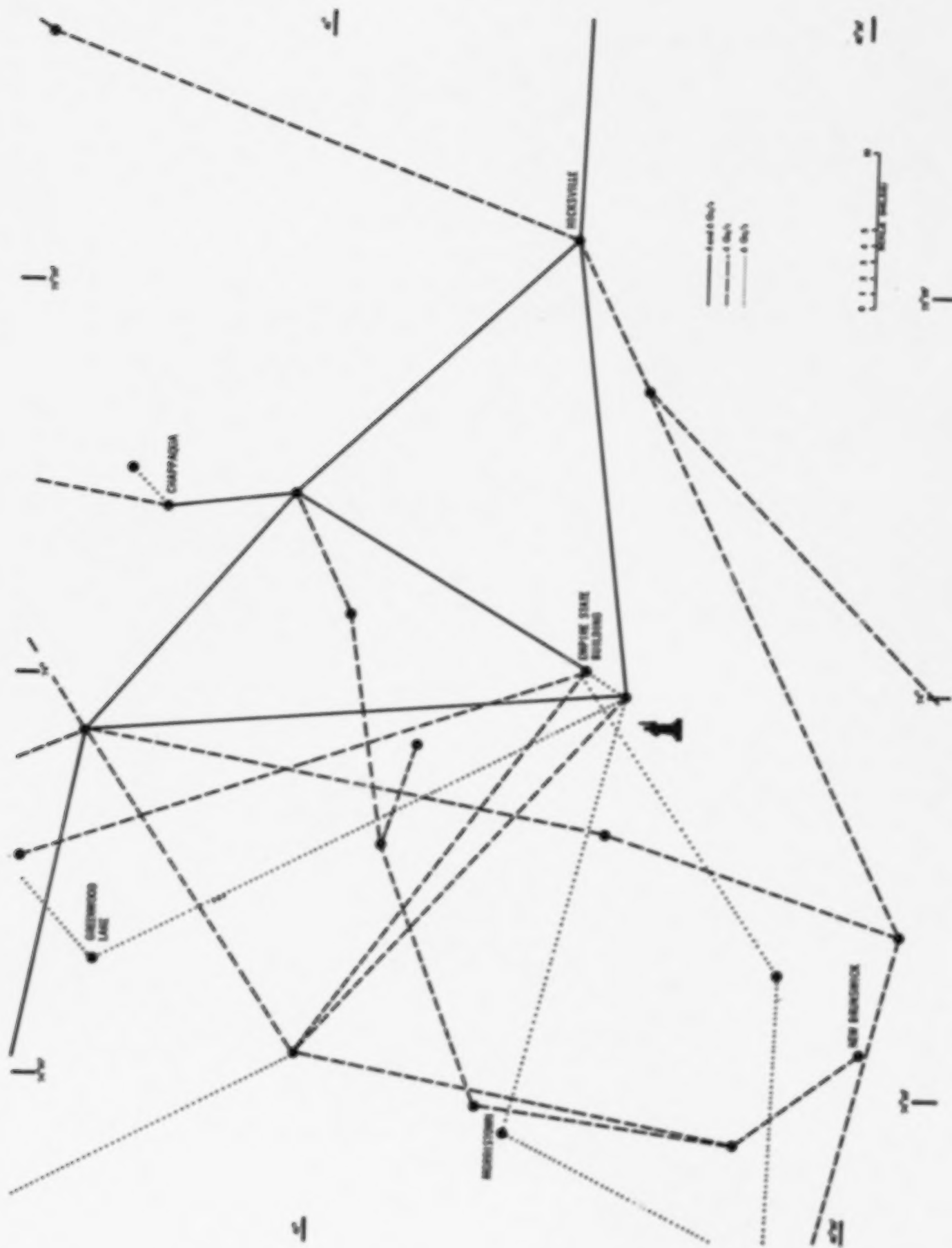


Figure 4.1 Locations of Microwave Relay Facilities near New York City

Besides the data shown in Figure 4.1, it is necessary to consider all microwave facilities out to 275 miles for the case of scatter interference from the common-carrier transmitter to the earth station receiver in the 4 Gc/s band. In determining the various interference contours the full horizontal pattern of the common-carrier antenna is utilized, while for the cases of precipitation scatter interference only the main beams will be considered. The parameters shown for Equation 4.3 are assumed with $G_{EH} = -24$ db, yielding $\rho_2 = 127$ and $\rho_4 = 116$ db. The gain of the transmitting antenna in the horizontal plane will be assumed to be omni-directional. The conclusions can then be modified to account for the actual measured horizontal pattern.

Figure 4.2 shows the areas which are excluded by Case 4 local interference. Within the region of consideration, potential interference to and from the microwave facilities is considered from all directions. The contours surrounding the stations are a rough approximation to the horizontal gain pattern of a horn reflector. Figure 4.3 shows the areas which are excluded by Case 2 interference over the direct path. It is interesting to note the effect on the excluded area of varying G_{EH} . If it is increased to -19 db, ρ_2 will then become 132 db and the area which will avoid this type of interference is shown in Figure 4.4. Comparison of Figures 4.3 and 4.4 emphasizes the need for effective site shielding and low antenna side-lobe gain in a metropolitan area.

Figure 4.5 shows the excluded areas for Case 4 interference via the scatter path considering stations out to 150 miles from the edges of the area

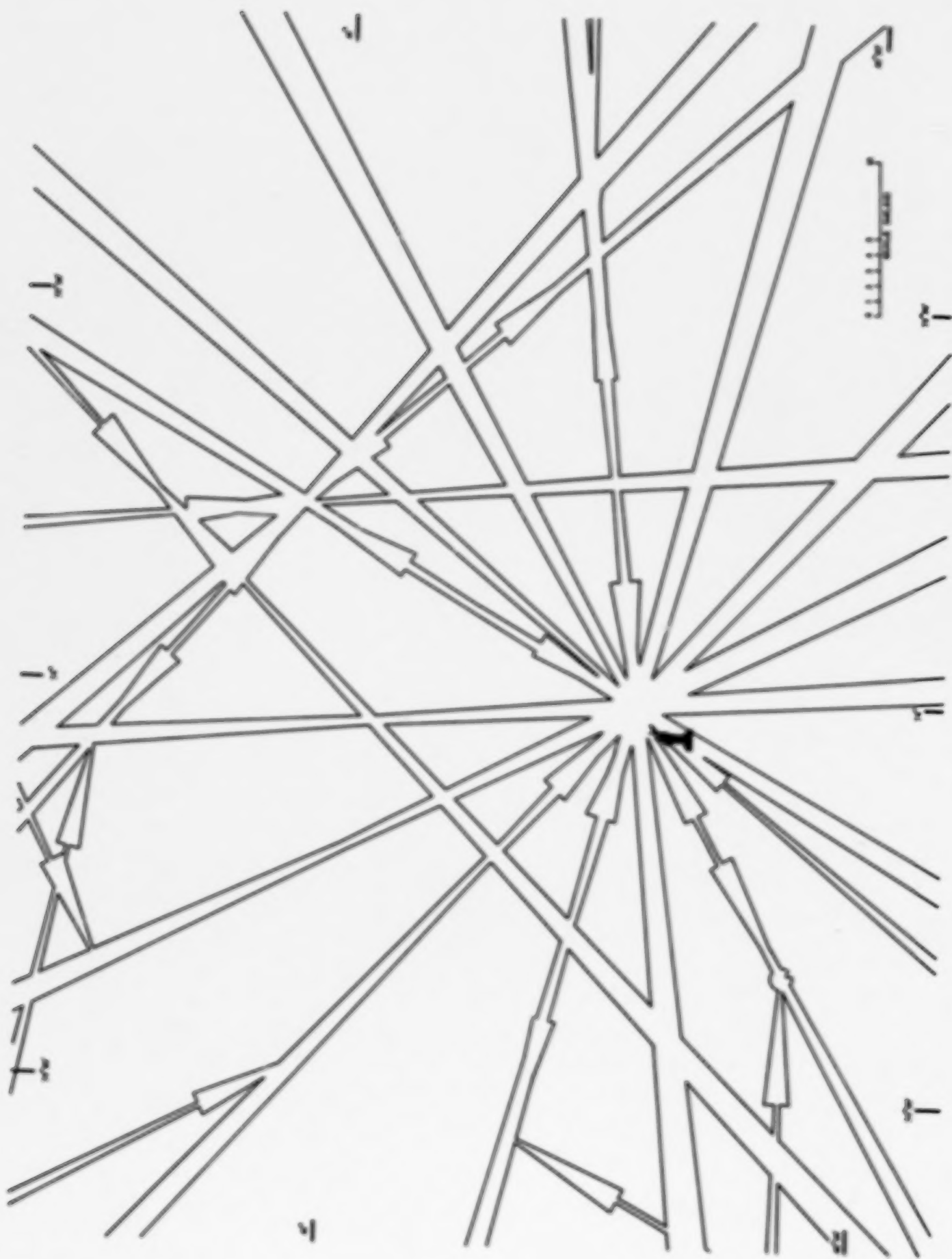
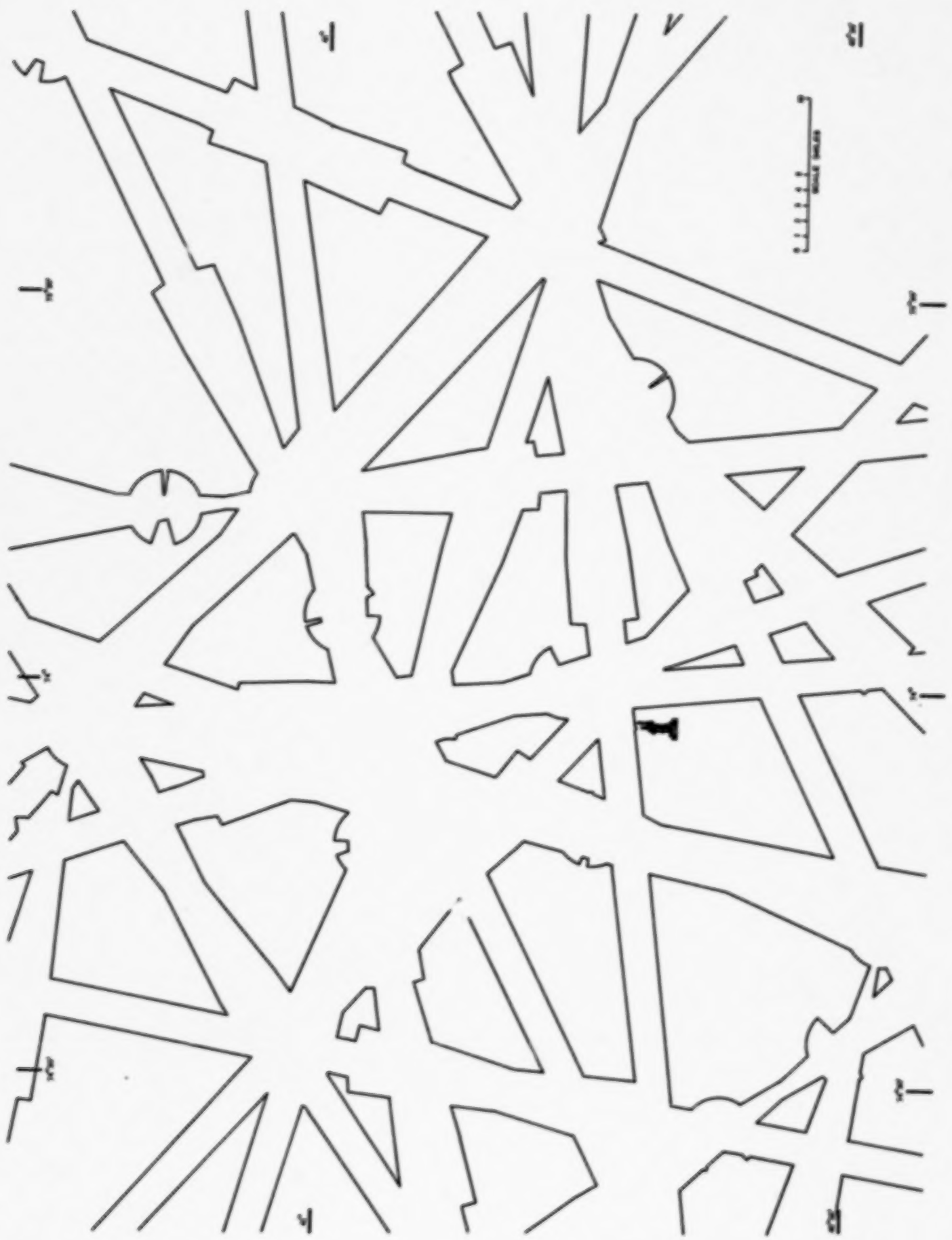


Figure 4.2 Area Excluded Due to Direct 6 Gc/s Interference, $\rho_k = 116$ db



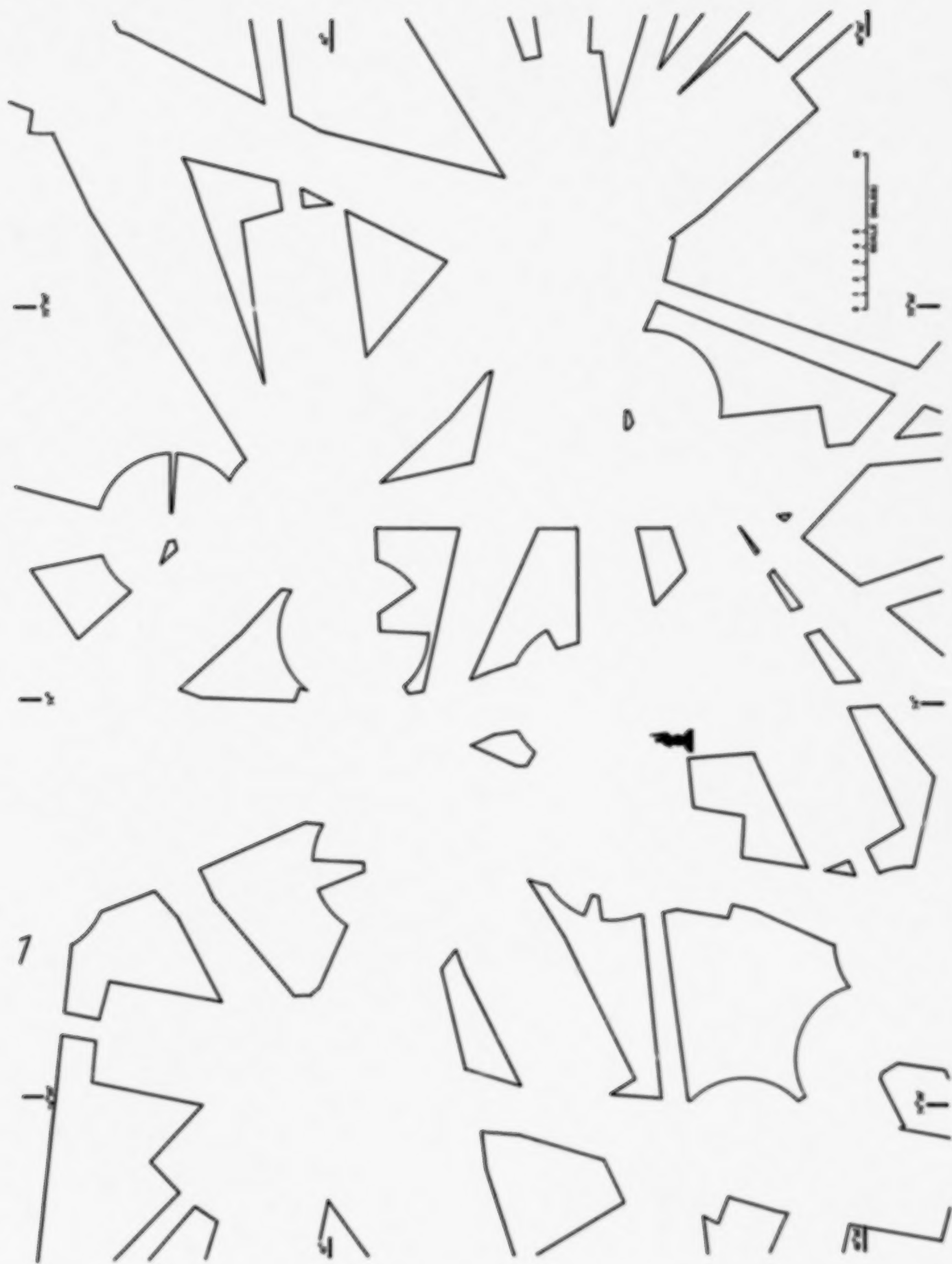


Figure 4.4 Area Excluded Due to Direct 4 Gc/s Interference, $\rho_2 = 132$ db

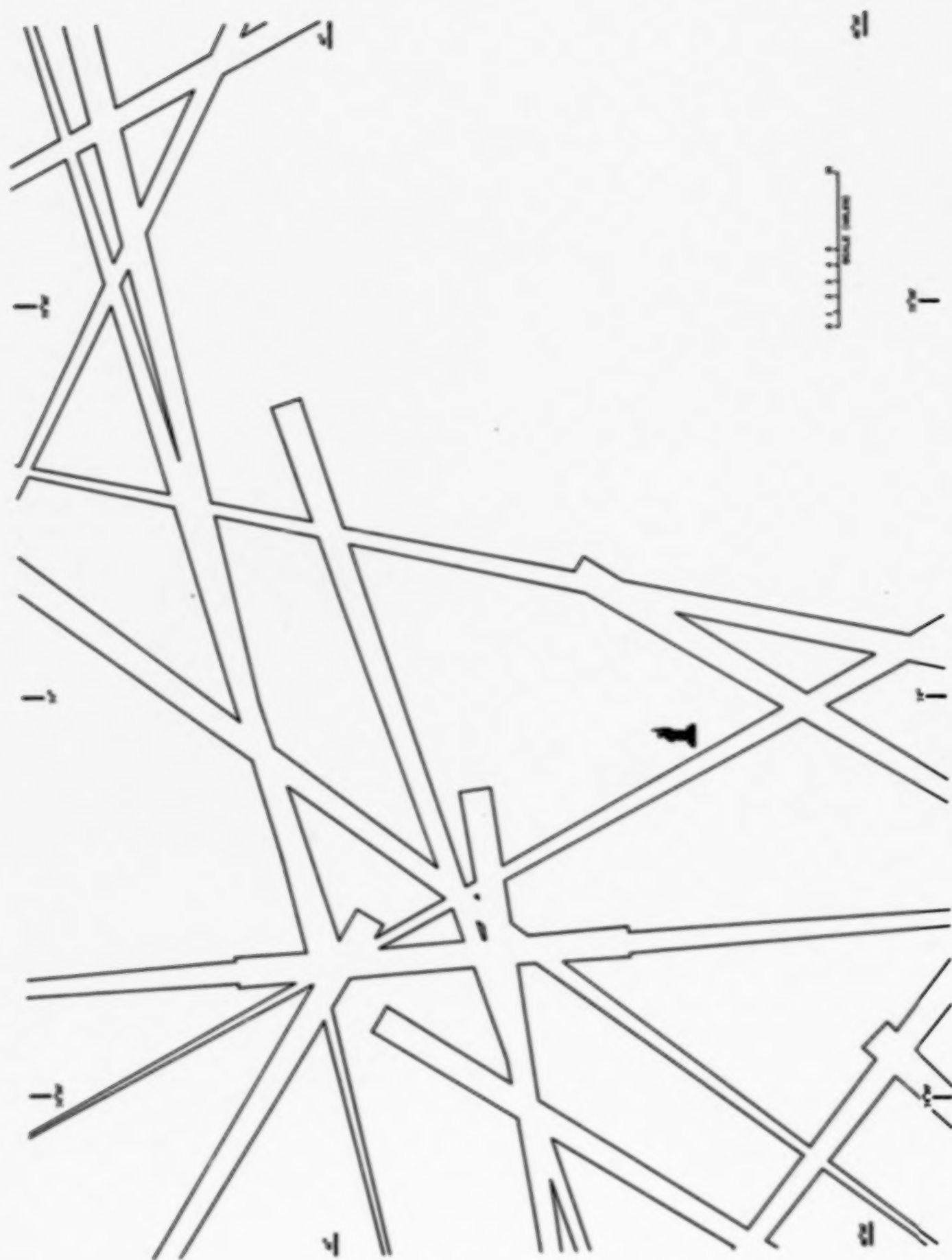


Figure 4.5 Area Excluded Due to Scatter into TH Stations at Ranges up to 100 mi.

considered for siting. This radius of consideration errs in the direction of increased interference, as seems appropriate pending more complete measurements.

Figure 4.6 shows the areas which are excluded due to Case 2 interference via the scatter path for interfering stations located within 100 miles of the edges of the area considered. Figure 4.7 shows the areas which are excluded by considering precipitation scatter interference from stations located between 150 to 275 miles from the siting area. Because of the distance of the transmitter stations and the width of their beams in the vicinity of New York, a large area is excluded from consideration due to interference from the more distant microwave facilities. It is important to realize that less pessimistic assumptions in defining the scatter characteristics reduces the radius of consideration of interference sources and increases freedom of site selection. The approximate distance to each of the stations can be estimated by the width of the beam shown within the New York area. The increase in acceptable area resulting from eliminating interference from these stations can then be estimated.

It is also important to note that some of the interfering beams considered can be eliminated by topographic considerations. For the purpose of this preliminary study, a conservative estimate of acceptable siting areas was desired and topographic considerations were not employed.

Figure 4.8 shows the area that is not excluded by any of these considerations and, therefore, open to consideration for siting an earth station. The net

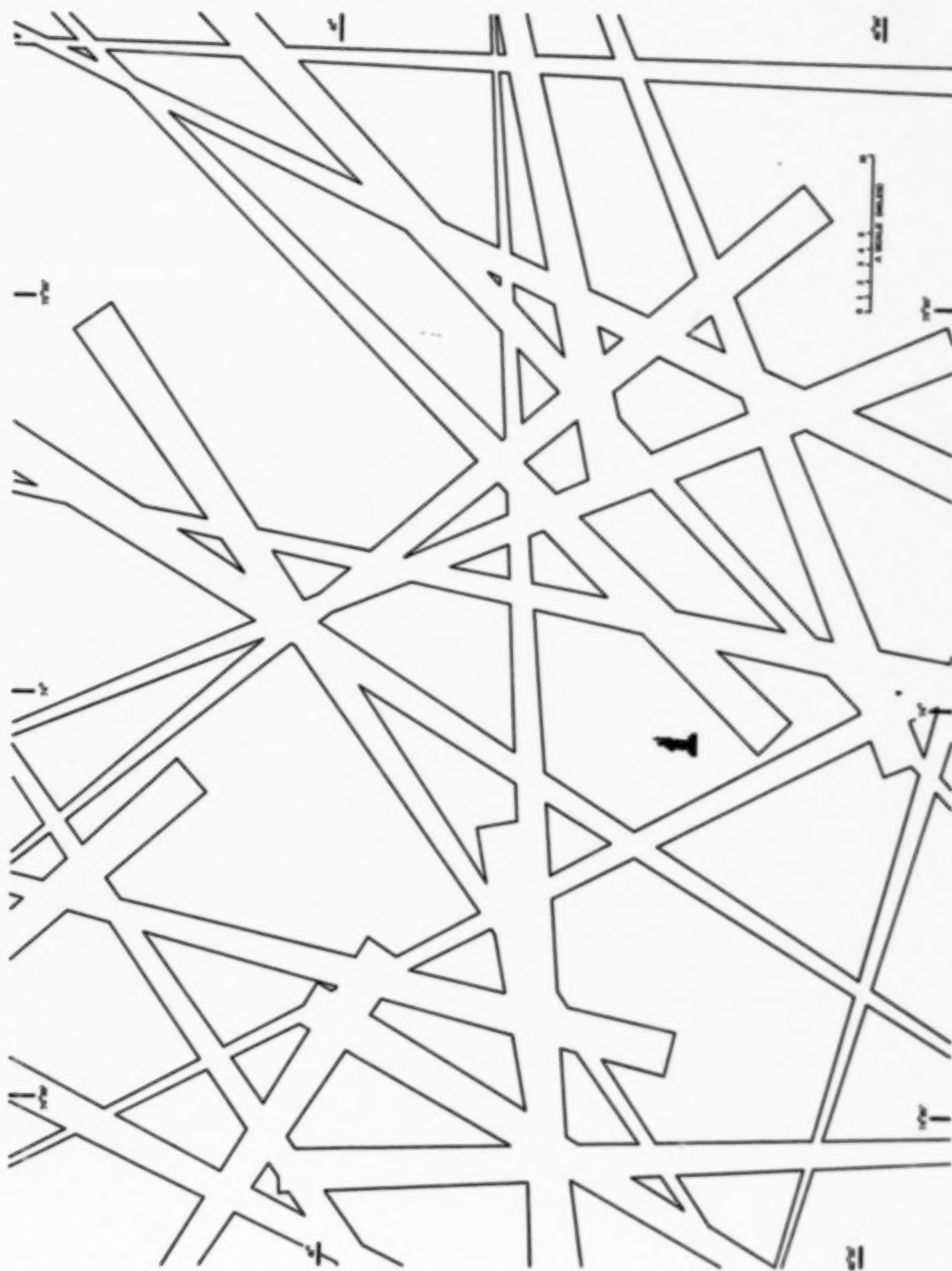


Figure 4.6 Area Excluded Due to Scatter from TD-2 Stations at Ranges up to 100 mi.



Figure 4.7 Area Excluded Due to Scatter from TD-2 Stations at Ranges of 100 to 275 mi.

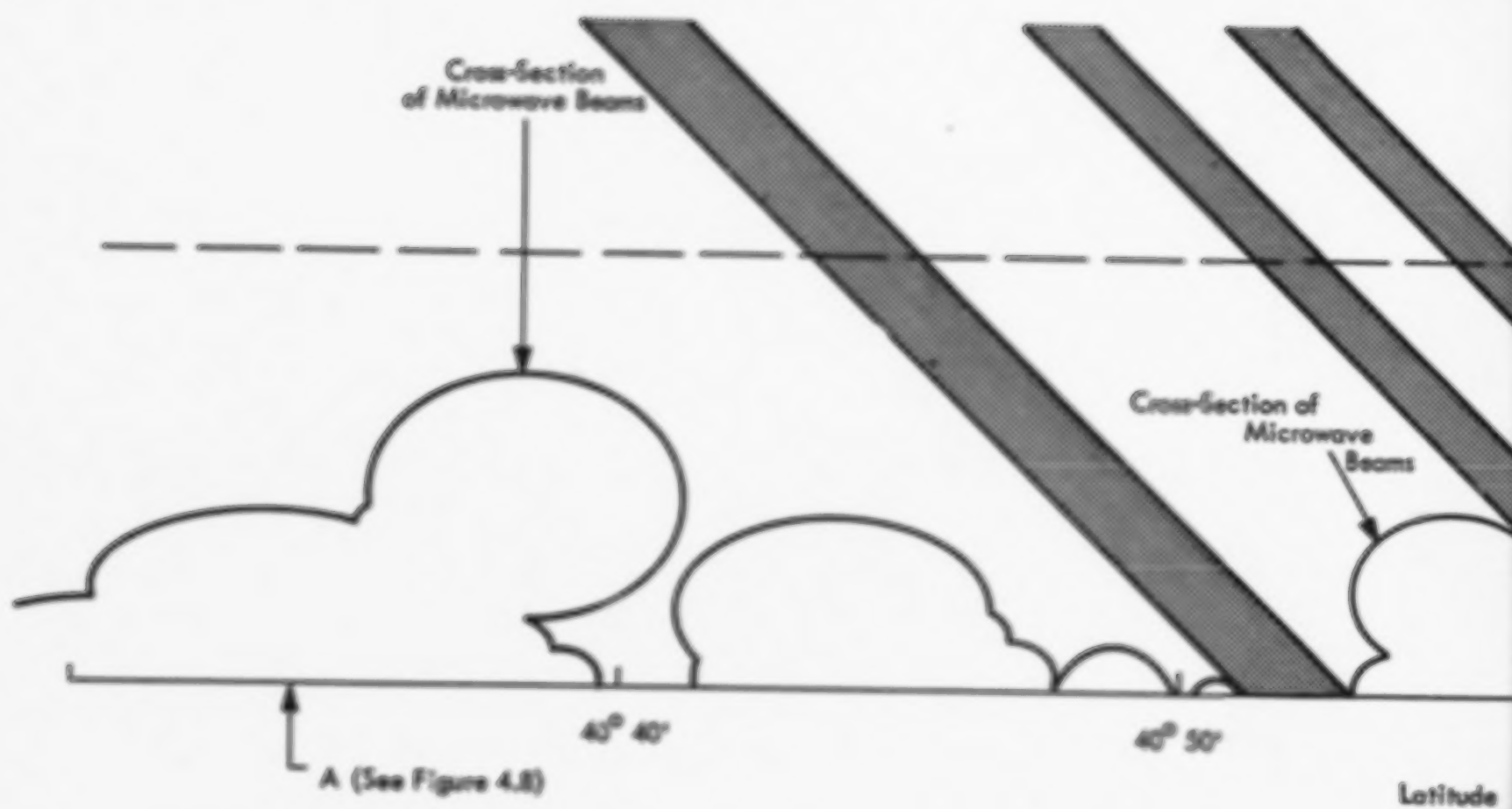


Figure 4.8 Areas for Consideration in Siting BNS Earth Stations

area in Figure 4.8 is obtained by blocking out the interference contours shown on Figures 4.2, 4.3, 4.5-4.7. Figure 4.2 is based on the assumption that the carrier dispersion signal will reduce the effect of Case 2 interference by 5 db. Since experimental results are not presently available to support this assumption, a more conservative estimate of the area available for consideration is obtained by using Figure 4.4 in place of 4.3 in the mapping procedure employed here. Figure 4.4 is drawn for a value of ρ_2 that is 5 db higher than that used in Figure 4.3 and, therefore, corresponds to the assumption that no reduction of interference effects is provided by the carrier dispersion signal. The net area resulting from merging Figures 4.2, 4.4-4.7 is shown in Figure 1.1.

To this point, interference contours have been described in the horizontal plane. For distant stations the beams will actually be elevated and a profile drawing must be constructed or an equivalent calculation performed to ensure that the earth station beam will not intersect a common-carrier beam at any point. Figure 4.9 shows such profiles which cut through several potential siting regions indicated by Section A-A in Figure 4.8. As illustrated in the figure, some of these regions are truly acceptable for siting, while others are blocked by elevated beams which intersect the line of sight to the satellite. In other cases, a profile view would disclose regions available for siting which might have been obscured in the plan view.

Figure 4.9 is an example based on a smooth earth approximation. To predict the beam elevation accurately, the site elevations, antenna heights, and



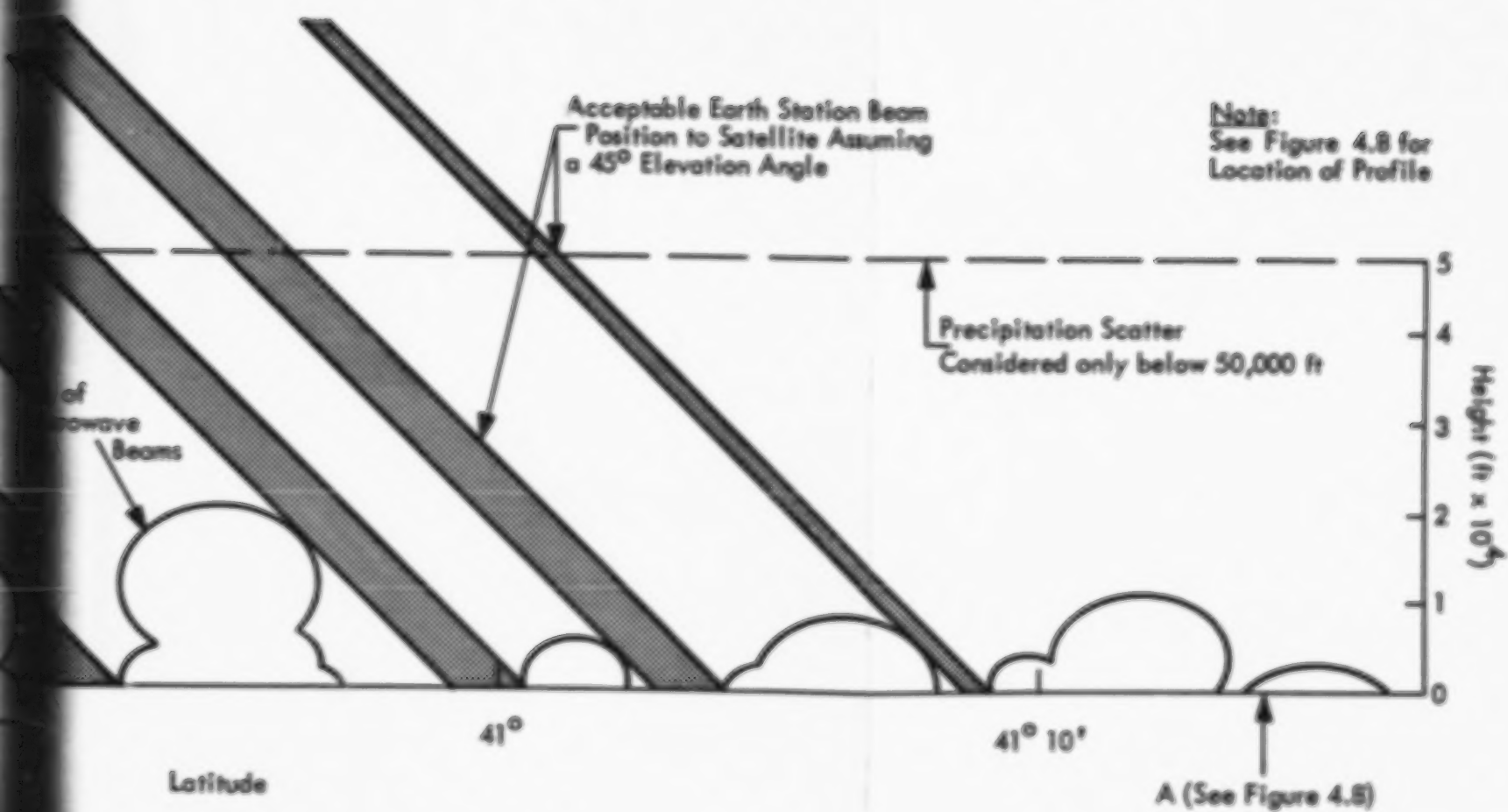


Figure 4.9 Profile of Volumes Excluded to the Main Beam of the Earth Station

pointing angles must be taken into account. The beams that produce most of the adjacent blockage are wide beams from distant sources with beam centers at 10,000 feet or greater. The elevation and antenna height of most common-carrier facilities are small. For this reason, it is felt that the adjacent blockage problem is fairly accurately represented here, and, that only minor changes in beam elevation will be found when antenna heights and pointing angles are taken into account.

Figure 4.9 was constructed with the assumption that the cross-section of the common-carrier beams were circular, when actually they are elliptical with the major axis in the vertical plane. A safety region should be placed around each beam to account for variation in beam bending due to changes in air pressure and temperature.

In the sample problem, data was accumulated on the types of antennas used by common-carrier facilities in the New York local area. It was found that at least four antennas of 4 and 6 Gc/s facilities did not use horn reflectors. Considering antenna data filed with the FCC and presented in Figures 3.2 and 3.3 led to coordination distances much larger than the horn reflector stations. If required for satisfactory siting, these antennas could be replaced by horn reflectors at an additional expense small in comparison to the incremental cost of locating a BNS terminal in an exurban area.

The sample problem has dealt with siting major BNS terminals in a metropolitan area. For completeness, the problems involved in temporarily

siting the BNS remote pick-up stations must be considered. The significant features of these stations are a 15-ft parabolic antenna (gain = 46 db), a transmitter power of 50 watts and single-channel operation in a transmit-only mode of operation. For the most part, it can be assumed that the remote pick-ups will operate in areas at a considerable distance from a BNS earth terminal. In locating the pick-ups, interference from the pick-up transmitter to the common-carrier 6 Gc/s receivers must be considered (Case 4 interference). For a 15-ft antenna with a main-lobe gain of 46 db, a G_{EH} of -5 db can be obtained. From Equation 4.2, $\rho_4 = 132$ db. The size of each of the interference contours surrounding the common-carrier facilities is approximately the same as is shown in Figure 4.4, allowing for the difference in frequency. Approximately 90% of the 6 Gc/s common-carrier facilities in the vicinity of the remote pick-up will be eliminated from interference consideration due to the difference in the frequencies of operation. The area for possible siting of the remote pick-up will be quite large. Since the remote pick-up employs a transmitter power less than that of the BNS earth station terminal, interference to the common-carrier facilities via the precipitation scatter path should be less than for the BNS earth station terminal. Since the range of consideration for precipitation scatter interference from the BNS earth station terminal was quite small, it is not necessary to consider precipitation scatter from the remote pick-up facility.

4.3 Critique and Conclusions

The potential siting regions shown in Figure 4.8 are small relative to the total area of consideration and are well dispersed. The inclusion of the effect of the beams of common-carrier stations which may have been overlooked or are presently under construction should not appreciably affect the potential siting area. Approximately 86% of the area considered lies under one or more microwave relay beams. About half of the remaining area is blocked by elevated beams as shown in Figure 4.9. A small amount of area is available under beams and does not show up in Figure 4.8. It can be estimated that approximately 7% of the total area considered is available for siting -- on the basis of interference considerations alone.

In the example G_{EH} was considered omni-directional. It actually has a directivity associated with it and some points on this pattern result in much lower side lobes than the omni-directional envelope considered in the example. In the construction of the site these optimum suppression lobes can be oriented toward stations of greatest potential interference.

Consideration of the aircraft scatter problem requires that areas of several square miles near the three major airports near New York City be excluded for siting purposes along with smaller areas near other airports. Using the net area shown on Figure 4.8 as a basis, exclusion of the three major airports eliminates a negligible fraction of the area available for siting. Exclusion of circles five miles and ten miles in radius and centered on these airports

eliminates 0.7% and 10.2% of the net area respectively.

Preliminary study of flight profiles indicates that the probability of flying through the BNS beam can be reduced to tolerable levels if the BNS earth station is located at least five miles from the end of a runway. Detailed study of plan views of traffic patterns at each airport is necessary to determine the best shape for the area to be excluded around each airport. Clearly, circular areas of exclusion are not optimal as it is desirable also to exclude areas under the most heavily traveled corridors into and out of each airport.

Thus, aircraft scatter considerations are largely included in the precipitation scatter problem as far as New York City is concerned. Adding aircraft scatter to the problem results in a significant increase in the excluded area, but an adequate number of sites remain even in the dense New York City situation.

From the example for New York City, it is possible to judge the difficulty in siting at other locations by considering the number and density of microwave facilities in their immediate vicinity. Most locations will have fewer local common-carrier facilities than New York. The areas excluded in Figures 4.2 and 4.3 due to local interference will be much less for the same set of BNS system parameters. Most locations will also have many fewer distant common-carrier facilities that must be considered for precipitation effects, since New York City is located near many other metropolitan areas. A comparison of the FCC maps of microwave facilities for Atlanta, Denver and Washington, D.C. with those of

New York City indicates that the siting problem in the Washington area will be slightly less constrained than in New York City and that siting in Atlanta and Denver will be much less constrained.

Other conclusions of this preliminary study of the BNS siting problem in the New York area are as follows.

- A gain of -24 db in the direction of a potentially interfering common-carrier station must be achieved through antenna design and side-lobe suppression techniques for the BNS earth station in dense metropolitan areas to obtain sufficient freedom in site selection.
- The potential interference is greater in the case of interference to the BNS terminal than for the case of interference to the common-carrier facility.
- For the case of precipitation scatter interference to the BNS earth station receiver, potentially interfering common-carrier facilities must be considered out to a range of 275 miles.
- Measurements of scatter cross-section of large aircraft are needed for all angles of scattering particularly for scattering angles between 45° and 135° .
- The degree of area exclusion from siting consideration due to each important interference case is given in Table 4.2.
- Measurements of the psychophysical effects of the common-carrier interference with the BNS down-link signal are required to determine: (1) the degree of Case 2 interference reduction provided by the proposed carrier-dispersion technique, and (2) the best assignment of BNS carrier frequencies relative to TD-2 carrier frequencies.

In order to achieve sufficient freedom in site selection, it may be necessary to replace as many as two or three common-carrier antennas having insufficient side-lobe suppression with

horn reflectors for each metropolitan area where a BNS earth station is to be located.

Table 4.2 Areas Excluded by Interference Effects

Interference Situation	Range of Consideration (mi)	Area Eliminated (%)	Figure Number
Case 2			
Direct	0-40	60	4.3, 4.4
Precipitation	40-100	50	4.6
Precipitation	100-275	50	4.7
Case 4			
Direct	0-40	25	4.2
Direct and Precipitation	40-100	25	4.5

- Regulatory agencies may wish to consider allocating not only spectrum and transmitter locations but also beam width, power, azimuth, altitude and elevation.
- The terrestrial microwave system tends to grow by adding spectrum to the existing links, much of which presently occurs outside the shared bands. Thus, this growth need not obliterate the areas presently open to metropolitan siting of BNS earth stations, provided that early decisions are made to reserve some of these allocations for the proposed use.

- Preliminary studies of aircraft scatter indicate that short intervals (less than 1 second) of interference will occur rarely. The system design considerations used to control precipitation scatter will also greatly reduce aircraft scatter. If the BNS earth terminal is located so that the main beam does not intersect low-altitude airways, the interference via aircraft scatter will occur for a tolerably small fraction of the time.
- For small fractions of the time (e.g., 0.02%), BNS signals will be noticeably below the high quality expected most of the time. Present network signals experience outages for similar fractions of the time.
- Of the total area considered for possible siting in the vicinity of New York City, 86% is found to be under one or more common-carrier beams as shown in Figure 4.8. Of the remaining 14%, about half of the sites will pass the profile check illustrated in Figure 4.9 and, thus, be acceptable for siting as far as interference considerations are concerned.
- The acceptable area is well dispersed throughout the region of consideration. Several different types of locations will then be acceptable for siting the earth stations.
- New York City is a severe example of potential interference, probably the worst in the country, considering both the direct path and the scatter path.

Before actually siting an earth station a more detailed siting study must be undertaken, including the considerations outlined in the sample problem above. Measurements of common-carrier field strengths must be made at various altitudes and locations near potential sites. However, the study conducted here for the New York metropolitan area -- in a communications sense, probably the most congested in the United States -- shows that it is feasible with only

moderate difficulty to find a number of areas for BNS sites. Some of these areas may lie within only one microwave hop of the Empire State Building. There will be even less difficulty in siting the other BNS terminals since the preponderance of these will be located away from the major metropolitan areas.

3. Glossary

α	Angle of arrival of satellite signal relative to the main beam of a common-carrier antenna
Case 1	Common carrier interfering with satellite receiver
Case 2	Common carrier interfering with BNS earth station
Case 3	BNS satellite interfering with common carrier
Case 4	BNS earth station interfering with common carrier
CCIR	Comité Consultatif International Radio
C/I	Ratio of carrier power to interference power
cm	Centimeter
c/s	Cycle per second
db	Decibel, a logarithmic unit of power ratio (the number of db corresponding to a power ratio r is given by $10 \log_{10} r$)
dbw	A unit of power expressed in db above one watt
ERP	Effective radiated power or, more exactly, equivalent isotropic radiated power, i. e., radiated power multiplied by antenna gain above an isotropic radiator
F_B	Received power density scattered from the volume of a rainstorm, common to the main beams of interfering and interfered antennas
F_L	Received power density scattered from the volume of a rainstorm in the main beam of the earth station, visible from a common carrier facility

G_{CH}	Gain of common-carrier antenna in horizontal plane
Gc/s	Gigacycle per second = 10^9 c/s
G_{EH}	Gain of BNS earth station antenna in horizontal plane
hr	Hour
ITU	International Telecommunications Union
Kc/s	Kilocycle per second = 10^3 c/s
λ	Wavelength
m	Meter
Mc/s	Megacycle per second = 10^6 c/s
mi	Statute mile
mm	Millimeter
pwp	Picowatt (10^{-12} W), psychometrically weighted, a unit of power which weights interference at various frequencies to account for psychophysical effects
Q	Rainfall rate (mm/hr)
R_i	Separation required between a common-carrier facility and a BNS earth station to control Case i interference, $i = 2, 4$
P_i	G_{EH} (Transmitted Power)/(Tolerable Interference) for Case i interference, $i = 2, 4$
σ	Scattering cross-section (m^2), i. e., ratio of scattered power to the power density incident on the scatterer

TD-2	Common-carrier system operating in the 3.700-4.200 Gc/s band
TH	Common-carrier system operating in the 5.925-6.425 Gc/s band
w	Watt, a unit of power

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